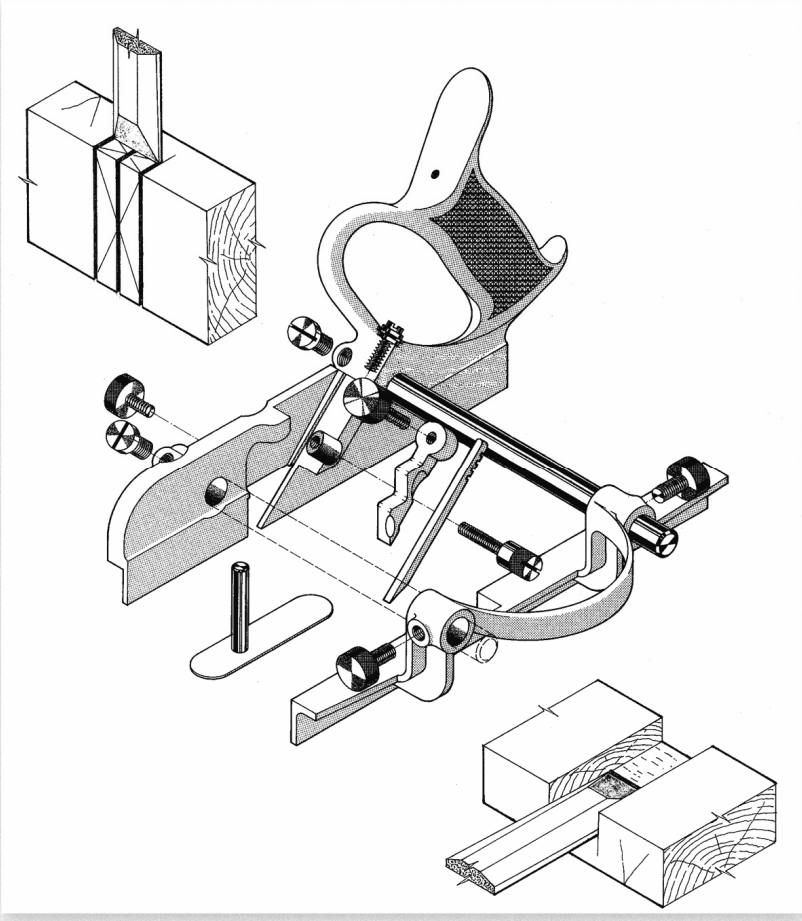
Carpentry - Housing

Building Materials and Hand Tools



NEW SOUTH WALES DEPARTMENT OF EDUCATION AND TRAINING
TAFE NSW
CONSTRUCTION AND TRANSPORT DIVISION

CARP02/1

Publishing details:

These notes were prepared by

Teachers of Carpentry
TAFE NSW

2003 Edition

Construction & Transport Division
Western Sydney Institute of TAFE

For Construction and Transport Division
TAFE NSW

Victoria Road
Castle Hill NSW 2154
Ph. (02) 9204 4600

First Published 1999
Second Edition 2003

ISBN 0 7348 0998 0

Published by
Construction and Transport Division

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Acknowledgments:

Acknowledgment and thanks is due to the following for their permission to reproduce product materials and/or copyright materials;

- Bankstown TAFE College - For use of workshop and facilities for photography of tools and equipment.
- Maurie Tate - for your valuable contribution in the preparation of this Unit.
- Rob Young - For preparing and editing these notes, including all new graphics.
- Ivanka Susnjara - For desktop work and preparation for printing.
- Resource Distribvution - for printing and distribution, Unit 3/61-71 Rookwood Road, Yagoona, NSW, 2199.
- Special thanks - to Bob Bulkeley for the many years of dedication to research, development and production of quality resources for use in the area of vocational education.

BUILDING MATERIALS and HAND TOOLS

This text addresses a variety of subject matter related to Building and Construction, at a basic level.

It should be read in conjunction with “Basic Building and Construction Skills”, produced by TAFE and Addison Wesley Longman Australia Pty Limited, as between them they address the following:

A broad overview of structural building elements is provided outlining details of specific nominated sections, which highlights the complex nature of construction in general;

A wide variety of common hand tools available for use in the building and construction industry and also the use and maintenance of specific carpentry tools;

Details of the preparation and construction of a variety of commonly used construction and joinery joints is provided;

Descriptions and examples of various formal drawing techniques are outlined, including trade drawing conventions;

A comprehensive ‘Glossary of Terms’ is included at the end of the text, which provides a detailed description of trade terms, technical content and some trade jargon.

TIMBER - As a Building Material

Timber, as outlined in 'Basic Building and Construction Skills, is a material which is produced by plants and in particular, trees. Trees are made up of a variety of materials which include cellulose, hemicellulose, extractives and the hard material which binds all the elements together, called *lignin*.
All trees belong to one of two groups, known broadly as 'Softwoods' and 'Hardwoods'. The oldest forms of trees known are those which fit into the Softwood group, also known as '*conifers*', of which there are around 600 species world wide. The hardwoods evolved from the softwoods and have a more complex structure. They grow readily and widely around the world consisting of many thousands of species some of which were transported by early explorers, which is why the common Australian eucalypt is found in places like Portugal.

Old Growth Forests

These are areas of naturally occurring forest which are made up of many different species of timber. These forests have been in existence for thousands of years, with some individual trees being in excess of three hundred years old, such as the 350 year old Mountain Ash found in Tasmania. These trees rely on fires, birds, animals, insects and the wind to regenerate and spread the seeds further afield. Logging in these areas generally requires a variety of heavy destructive machinery to create access roads so isolated pockets of forest may be reached. Harvesting of specific old growth timbers is not always well managed and this often leads to large tracts of forest being flattened, and sometimes burnt off, which removes the top soil bonding network created by the trees root system. This inevitably leads to top soil erosion which causes further damage to the surrounding forest and prevents natural re-generation. Also, other plants, animals and birds which are endemic to the area may be driven off, killed, or in extreme cases, become extinct.
Therefore, sustainable old growth forest logging requires careful planning with minimum impact on the surrounding flora and fauna, which is expensive and difficult to control.

Plantation Forests

These are classed as artificial forests as the trees are cultivated and planted rather than growing from seeds dropped by trees or carried by animals, birds or the wind. The seedlings are grown in controlled hot house conditions and then transplanted by hand or mechanical means. These forests are easily identified by the neat, evenly spaced rows of trees, which is done to allow maximum light and growing space. The space between the rows allows for purpose-made machinery to travel along an unobstructed path to harvest the trees, without damaging other trees, and to allow easy removal by road transport. The benefit of these plantations is that fewer old growth forests need to be disturbed, there is a high yield due to controlled growing and quick re-generation of the fast growing species planted, such as Radiata pine, Hoop pine and Slash pine.
Due to the well managed growing and harvesting of this resource, we now have a sustainable timber product with a wide variety of uses, produced at a reasonable cost.

There are several common softwood and hardwood species selected for use in general cottage construction and fixing out/finishing timbers, for their availability, cost, characteristics or quick re-growth qualities. These are outlined in the following table;

Timber Identification

TABLE 1
COMMON TIMBERS

COMMON NAME (and Botanical Name)	DESCRIPTION and USE
RADIATA PINE *(Pinus radiata)*	Also known as 'Monterey pine', it is a large softwood which originated from the west coast of North America and Canada but is now widely grown around the world in places like South Africa, South America, New Zealand, Spain, Italy, India and was introduced into Australia during the goldrush days of the 1850's. It has a pale yellow to brown colour with darker distinctive areas, which have a high resin content. It tends to be a rather hard timber, for a softwood, but is fairly lightweight and easy to nail with an ADD of around 500kg/m³. (see note for ADD) It is plantation grown and re-generates quickly after harvesting. The tree takes 30 years to mature and reaches a height of up to 30m. Once sawn to size it is kiln dried to prevent excessive warping and twisting. **Uses:** It is a very versatile timber, although it is not very durable, used for most residential wall and roof framing, furniture, mouldings, linings, panelling, and the manufacture of plywood, particleboard, fibreboard and paper. If it is treated, i.e. impregnated with Copper Chromium and Arsenic salts (CCA), it may be used for posts, cladding, landscaping, exposed floor framing, pergolas, etc.
DOUGLAS FIR *(Pseudotsuga menziesii)*	Also known as 'Oregon', is a commonly grown native softwood of North America and has been successfully grown in small plantations in New Zealand and Australia. It has a pale yellow-brown to pale reddish-brown colour which darkens with age. It is a versatile timber but is not very durable and tends to crack and turn brittle over time, when used for framing in hot roof spaces. It is also easily cut and nailed, but is surprisingly dense with an ADD of around 530kg/m³. **Uses:** It is was used widely for structural framing, joinery, door and window frames, cupboard frames and even boat building. It is rarely used externally due to it's poor durability rating, i.e. 'Class 4'. It tends to be more expensive than it's rival Radiata pine and is not used as extensively as it was earlier in the 20th century.

CYPRESS PINE White - *(Callitris glauca)*	This is a small to medium sized softwood grown in a wide ranging area of inland NSW and Queensland. It has a pale yellow sapwood and a heartwood section which is made up of variegated browns giving it a striped appearance. It also has many distinctive knots, making it difficult to mill knot free lengths. It has a very distinctive odour, like camphor, which always stays with the timber and may be detected when the timber is freshly cut. It tends to be quite hard and dense, for a softwood, with an ADD of around 680 kg/m³. The tree is fairly slow growing, taking around 50 years to reach a mature height of 10m. **Uses:** Cypress pine has many uses, due to it's *'Class 1'* durability rating and natural resistance to termite attack, such as tongue and grooved flooring boards, weatherboard cladding, timber floor, wall and roof framing, decking, posts, poles and panelling.
WESTERN RED CEDAR *(Thuja plicata)*	This is a very large softwood, which is native to North America and British Columbia, with considerable quantities being imported into Australia. This species of cedar should not be confused with the Australian Red Cedar *(Toona australis),* which is a Hardwood. It has a variety of colours found throughout the trunk ranging from a very pale cream/brown, to yellow, to pink through to dark brown. It also has a very distinctive odour which becomes evident when being worked. Some people have been diagnosed as being allergic to this timber and can have a very extreme reaction to the dust. It is a very soft, lightweight timber with an ADD of around only 350 kg/m³. **Uses:** WRC is considered to have a fairly good durability rating, i.e. *'Class 2'*, which allows it to be used externally as well as internally. It may be used for weatherboards, roof shingles, window and door frames and sashes, wall linings, joinery and fixout materials and outdoor furniture.
TALLOWWOOD *(Eucalyptus microcorys)*	This is a large hardwood, which is native to Australia commonly found along the coast of NSW and Queensland. It is mainly pale yellow to brown but has a hint of green throughout the heartwood. It is a dense, hard timber with a very wavy grain which is difficult to work. The surface of dressed Tallowwood has a 'greasy' feel to it which is caused by a natural oily extractive found in the timber. It has an ADD of around 990 kg/m³ and takes 40 years to reach a mature height of 30m. **Uses:** It is a very durable timber, i.e. *'Class 1'*, and is commonly used externally for decking, window sills and door thresholds, heavy engineering structures, sleepers, ridges, floor framing, posts and poles.

MOUNTAIN ASH *(Eucalyptus regnans)*	Also known as 'Tasmanian Oak', is a very tall hardwood found in the mountainous regions of Victoria and Tasmania. It is considered to be the world's tallest hardwood, reaching 98m in height, and has long straight grain with a pale pink to pale straw colour range. The timber is fairly dense with an ADD of around 680 kg/m³. **Uses:** It is not considered to be a very durable timber, i.e. *'Class 4'*, unless treated and therefore is more suited for internal use such as furniture, joinery, panelling, doors, veneers, flooring and tool handles.
STRINGYBARK Yellow - *(Eucalyptus muellerana)* (sometimes referred to as South Coast Hardwood)	It is a good quality medium to large hardwood commonly found on the south coast of NSW and Victoria.(other types- Red, White and Silvertop) It has a yellow/brown colour with an interlocking grain making it difficult to work or split. It is a dense, hard timber with an ADD of around 870 kg/m³ and a durability rating of 'Class 2' making it suitable for external use. **Uses:** Commonly used for floor, wall and roof framework, posts and poles, sleepers and retaining walls.
SPOTTED GUM *(Eucalyptus maculata)*	A large hardwood with a dappled white trunk commonly found growing from the south coast of NSW to the border of Queensland. The colour ranges from pale to dark brown with some wavy grain. It has a slightly greasy feel when dressed and has a hard dense make up with an ADD of around 950 kg/m³. It takes around 40 years to grow to a mature height of 30m. **Uses:** It has a fairly good durability rating, i.e. *'Class 2'*, and tends to weather quite well. It may be used for engineering construction, deck and balcony framing, posts and poles, flooring and tool handles.
MERANTI Light and Dark Red *(Shorea* spp.)	Also commonly called 'Pacific Maple' due to the large number of *Shorea* species available around the Pacific and South East Asia. It varies in colour from pale yellow to pink through to darker reds and browns. Stripped or ribbon grain is also common as well as the combination of straight and interlocked grain. It is considered to be a hardwood rainforest tree and many of the South East Asian forests are being destroyed due to the harvesting of this species. Large amounts were being imported into Australia in the past although it's importation has slowed due to availability and cost. It ranges in density from an ADD of around 640 kg/m³ to 720 kg/m³. **Uses:** It is a very versatile timber, although not considered durable and would fit into the *'Class 4'* range, used for panelling, veneers, joinery, fixing out, doors and plywoods.

BRUSH BOX *(Tristania conferta)*	It is a medium to large hardwood commonly found at the edge of rainforests from the mid east coast of NSW to the north coast of Queensland. Although it is similar in appearance to the common eucalypts it is not one of their species. There are however some species of eucalypt, which bear the name 'Box', such as Grey, Yellow and White-topped Box. It ranges in colour from a pink/grey to a rich red/brown and has a naturally occurring waxy surface making it a good hard wearing timber for internal use. It takes around 20 years to grow to a mature height of 15m and has an ADD of around 900 kg/m³. **Uses:** Although it is very resistant to termite attack it is not considered to be a durable timber, i.e. *'Class 3'*, as it is not resistant to decay. It is commonly available for use as flooring, panelling, some joinery and tool components.
GREY GUM *(Eucalyptus propinqua)* (sometimes referred to as North Coast Hardwood)	A medium to large hardwood found growing along the coast from the Hawkesbury river in NSW to south east Queensland. The colour ranges from a pale red to a rich red with an interlocked grain and it is this tree which is preferred by Koalas for feeding. It has a very dense nature with an ADD of around 1080 kg/m³ and takes around 30 years to reach a mature height of 16m. **Uses:** It is considered to be a very durable timber with a rating of *'Class 1'*, used for general and heavy engineering construction,

NOTE:

- ***ADD -*** This refers to the 'air dried density' of timber or it's mass after it has been seasoned or dried out to moisture content of 12 to 15%.

- ***Durability 'Class'-*** Refers to the ability of the timber to withstand the effects of weather, resistance to decay or fungal attack and its resistance to insect attack, such as termites and borers.

- ***Interlocked grain -*** This refers to the nature of the grain as it reverses or changes direction due to fibres in successive layers. Wavy and curly grain are similar to interlocked grain as fibres change direction from a straight direction. This does not weaken the timber but it does make it more difficult to work, i.e. plane, cut or chisel.

- ***Engineering construction -*** This refers to members used being used for structural applications where they form part of a load bearing, compressive or tensile design. Typical situations would be lintels, beams, bearers, joists, posts, struts, columns, etc.

CONVERSION OF TIMBER

Conversion is the sawing of a log into marketable sizes, and is best carried out as soon as possible after felling in order to reduce the loss of useable timber, due to end splitting of the log.
Whilst most logs are cut for maximum recovery, timber can be cut to suit specific situations or functions within a structure.
For example, finishing timbers may be cut to produce the best *figure* to expose the natural attributes of the timber grain, whereas structural timber may be sawn to produce the longest grain and reduce excessive or abnormal shrinkage.
There are several ways to convert the log into these marketable sizes, as shown below;

Live Sawing

This method is used to produce the largest number of wide boards, but control of shrinkage and warping is very difficult due to the variety of end grain shapes produced.

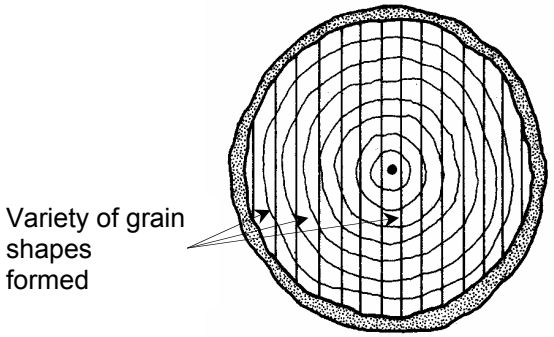


Fig. 1 Typical live sawing detail

Back Sawing

This is a common method used to produce a variety of back sawn boards. The result of back sawing is the end grain is seen as a series of arcs across the end width of the board, the edge has relatively straight grain and the face shows the best figure.

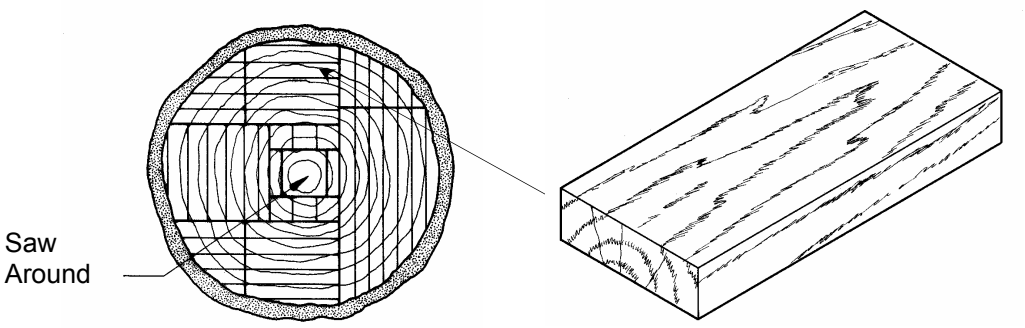


Fig. 2 Typical back sawing detail

Quarter Sawing

This method produces the least amount of useable boards from the log due to the cutting and re-cutting required ending up with the majority of boards having short end grain arcs running across the thickness, relatively straight grain on the edge and on the face.

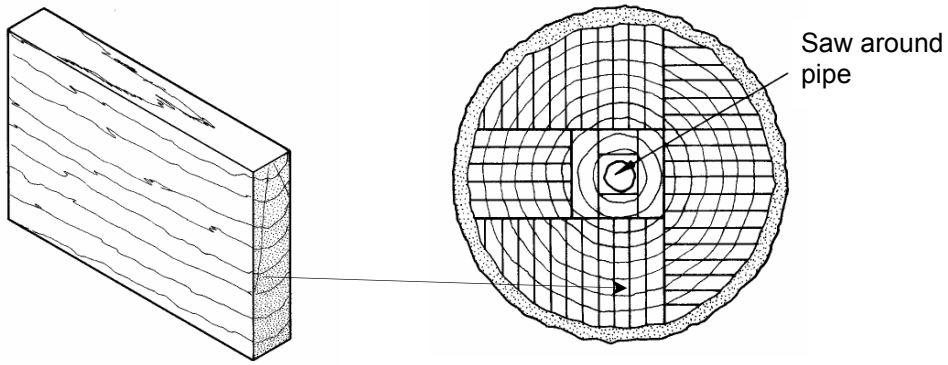


Fig. 3 Typical quarter sawing detail

Timber Shrinkage

As timber dries out it shrinks and this can lead to warping and splitting. The problems arising from shrinkage are complicated by the fact that the shrinkage is not equal in all directions.
Most timbers do not shrink excessively in length although shrinkage in width and thickness can be great. This will depend on the direction of the growth rings and their position in the timber, which is determined by the method of conversion used. There are three directions of shrinkage;

- *Longitudinal* - This is shrinkage which occurs along the length of the growth rings and as previously mentioned, it is minimal and not usually taken into account.

- *Radial* - This is shrinkage which is measured along the direction of the medullary rays. This is most apparent across the width of quarter sawn boards, as shown below;

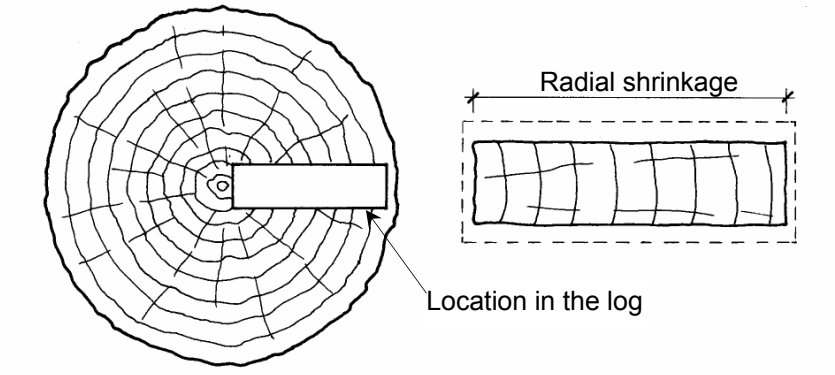


Fig. 4 Radial shrinkage

- *Tangential* - This is shrinkage which occurs along the growth rings, as seen on the end grain of back sawn boards, which causes them to shorten and leads to *cupping* of the timber face. It is also the most excessive shrinkage that occurs in timber.

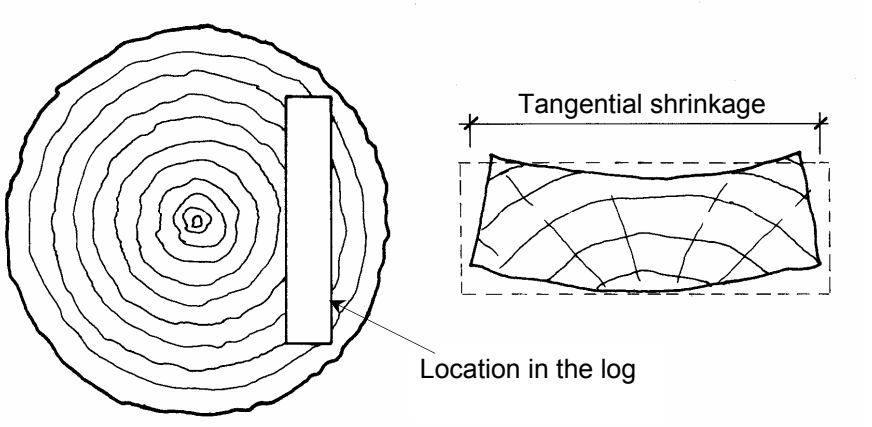


Fig. 5 Tangential shrinkage

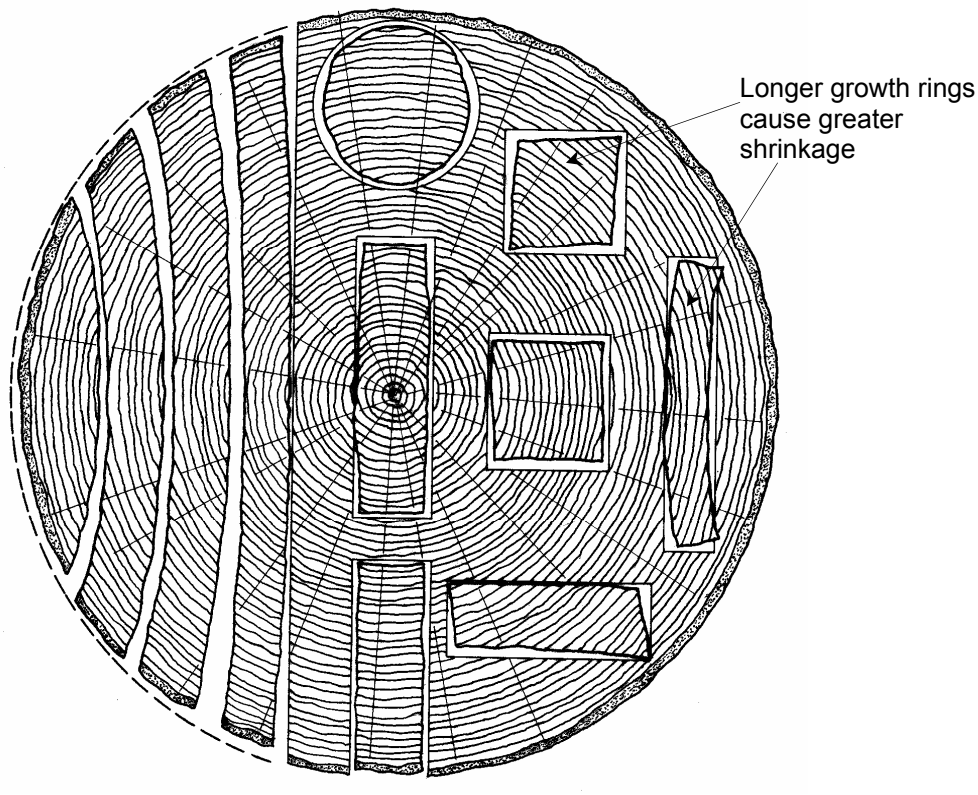


Fig. 6 Shrinkage and distortion

Timber Seasoning

When *green timber* is newly cut from the tree it contains large amount of *free water* in the cells and *combined water* in the cell walls. The purpose of seasoning is to remove all the free water and retain just enough of the combined water to prevent the timber cells from collapsing. This must be carried out in a controlled way to prevent the outside of the cells drying excessively before the free water has gone, otherwise excessive shrinkage and cracking will occur. If all the moisture in timber is removed the timber will collapse and loose many of it's natural properties such as colour, odour, durability and workability. Therefore, it is important to retain a small percentage of moisture to keep the timber 'alive', which is approx. 8% moisture content where the environment is naturally dry, such as inland country areas, and approx. 12% moisture content where the environment is naturally moist, such as coastal regions. When timber dries to these percentages it is said to have reached it's 'equilibrium moisture content'. Timber should not contain more than 18% moisture content as this renders the timber susceptible to timber decay and insect attack.

Natural Seasoning

This process involves the timber being stacked outside off the ground and covered to allow the air to circulate around each piece, which slowly dries out the excess moisture. The stack is covered with a slightly pitched roof to prevent direct heat from the sun drying the timber too quickly and to prevent rain from re-saturating the drying timber. The boards are separated by timber strips or *gluts* placed in vertical alignment with the cross bearers of the base to prevent warping and bending along the length of each piece. The stack should be set approx. 450mm off the ground to allow a free flow of air around the base and to enable possible termite activity to be discovered during regular visual inspections of the stack. The ends of the timber pieces are painted to seal them, or have timber strips nailed over them, to prevent excessive end splitting.
The time taken for natural seasoning depends on the following;

- The species of timber, i.e. is it a dense hardwood or an open grained softwood;
- The cross-sectional size, i.e. large cross sections will take longer to dry than smaller ones;
- The position in the stack, i.e. pieces in the centre will dry more slowly due to restricted air circulation, and;
- The weather conditions, i.e. quicker in warmer weather, slower in cold wet weather.
- The actual time taken from start to desired finish could range from 6 months to 2 years.

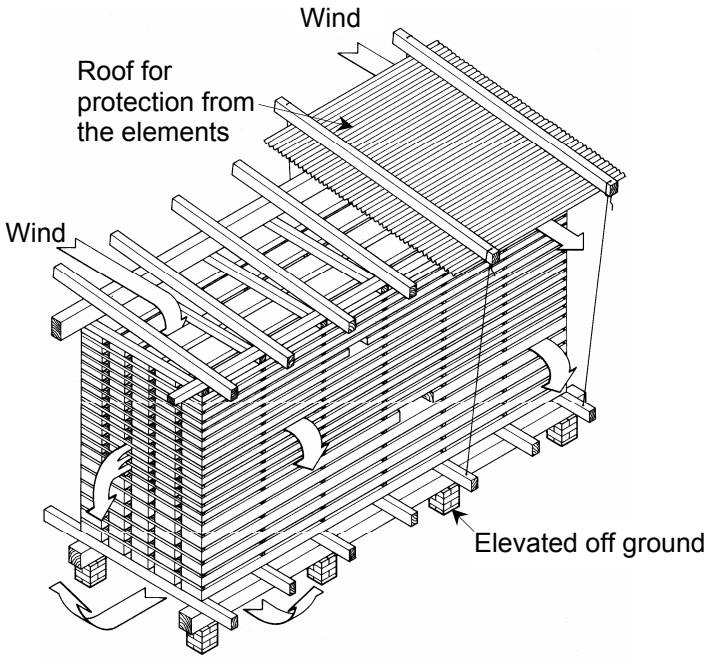


Fig. 7 Open air drying method

Artificial Seasoning

This is also referred to as 'Kiln drying'. The timber is stacked on low mobile trucks or trolleys with gluts to evenly space the pieces and is then rolled on rails into the kilns. This is a very controlled method of drying as the desired temperature and humidity levels may be maintained by adjustment of heat and fan blowing. There are two main types of kiln;

- Progressive kilns - the trucks are moved through progressively from one end to the other as the drying process is carried out;

- Compartment kilns - the trucks remain stationary while locked inside the kiln as the drying process is carried out.

With both these processes, heat is usually applied by way of steam coils. Skilled operators are needed to control the process to prevent warping, checking, collapse or any other faults which may occur due to rapid drying.
The time taken varies with the conditions, but generally ranges from 7 to 21 days.

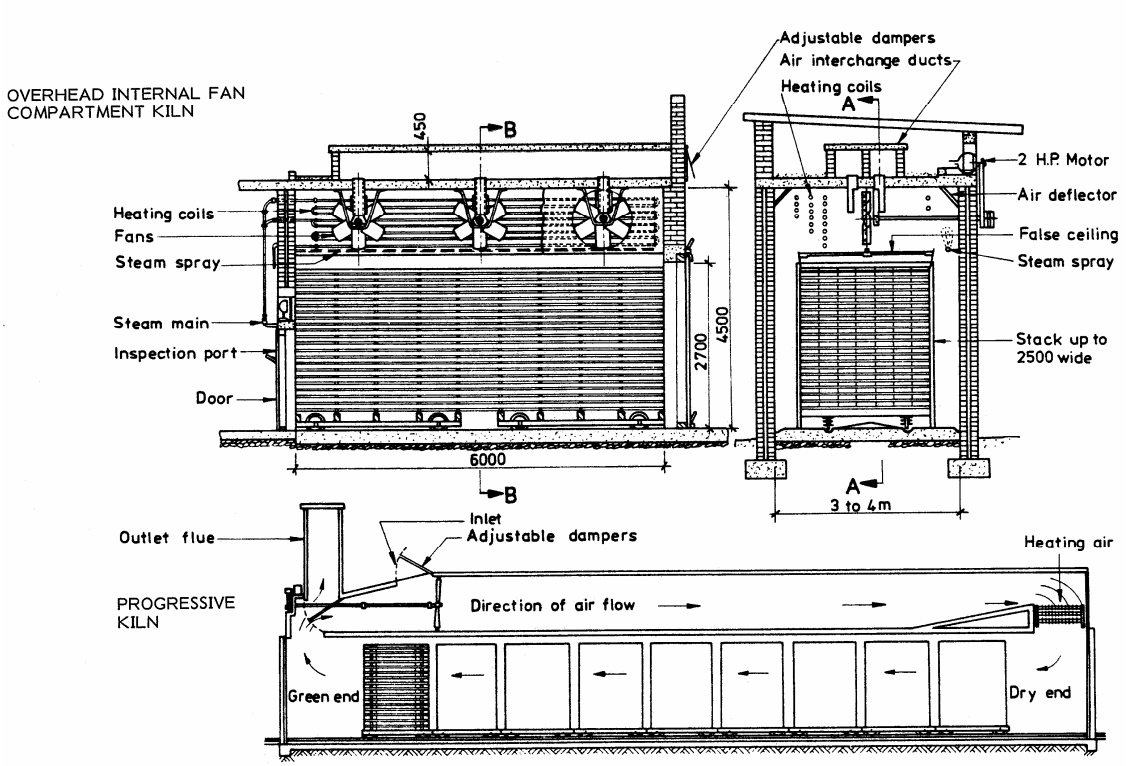


Fig. 8 Typical kiln types

Combined Seasoning

This method of seasoning is a combination of both natural and artificial seasoning. It allows the excessive water to be removed during the air drying process and then it is control dried in a kiln, until the required moisture content is achieved.
Other methods of seasoning include 'Chemical seasoning' and 'Microwave seasoning'. These are used for specialist timber uses such as carvings and golf club heads.

Timber Grading

Timber is graded so it may be classified for specific use. This is carried out by either visually grading or mechanically stress grading.

Visual Grading

This form of grading is carried out by an experienced person who looks for straightness of grain, blemishes or defects, then classifies the timber according to merit. For example;

- Timber which is free from knots, defects, has a straight grain and which is to be used for selected joinery is classed as 'Clear grade', sometimes referred to as 'No. 1 Clears';
- Timber which is free from knots, blemishes and defects is one suitable for selected plywood surfaces and is classed as 'Clear Face grade';
- Timber which has relatively few knots and is fairly straight grained would fall into the category of 'Select grade' or 'Engineering grade;
- Timber which has a number of knots and wavy grain which is suitable for use in smaller section sizes and lengths, such as wall framing, would be classified as 'Standard' and 'Utility grade'. This may also be referred to as 'Building grade'.

Visual grading may be carried out for softwood and hardwood and should comply with the requirements of the relevant Australian Standards, i.e. - *AS 1781 - 1975: Sawn boards from Australian grown conifers (softwoods) (excluding radiata pine and cypress pine), AS 2858 - 1986 Timber - Softwood - Visually stress-graded for structural purposes*, and *AS 2082 - 1979 : Visually stress-graded hardwood for structural purposes*.

Mechanical Stress Grading

This is a mechanical testing process for bending which specifies the structural property, marking and physical requirements for mechanically stress-graded timber. Physical requirements are given for strength considerations as well as for utility considerations. Timbers are given a number and a prefix of 'F' to indicate that they have been mechanically stress-graded and have a maximum bending stress shown MPa. For example, a stamp of 'F11' would indicate that the timber has been mechanically stress tested, 'F', and it has a bending stress grade of 11MPa.
Mechanical stress grading should be carried out in accordance with *AS/NZS 1784 - 1997 : Timber - Stress-graded - Product requirements for mechanically stress-graded timber.*

Colours for Marking 'F' Grades

There are ten (10) basic colours used to identify specific stress grades, which are either sprayed onto the face or end grain of the individual pieces. They are identified in AS 2700 and AS 1613 as;

TABLE 2

STRESS GRADE	COLOUR	STRESS GRADE	COLOUR
F4	Red	F14	Orange
F5	Black	F17	Yellow
F7	Blue	F22	Pink
F8	Green	F27	Turquoise
F11	Purple	F34	Royal Blue

MEASUREMENT OF TIMBER

Timber is measured, costed and ordered according to it's use and stated in the following units of measure, i.e.;

- Linear measure - the length of individual or multiple pieces;
- Square measure the surface size of sheet materials;
- Sets - made up or pre-cut units like door jambs and architraves;
- Number - individual pieces like fence palings, posts, sleepers;
- Cubic measure - large volumes of timber or large pieces of timber like baulks and flitches.

Length

Timber may be calculated and ordered by lineal measure or length. If bulk orders are made then only a total lineal measurement is required, however if the timber is to be used for specific purposes or to fit into a standard length space, then set lengths may be measured and ordered.
Individual lengths are calculated in increments of 300mm, ordered in metres and available in common lengths from 1.8m to 7.2m max., for ease of handling. Shorter lengths may be grouped together to make longer lengths, but must always be divisible by 300mm increments, as follows;

TABLE 3
STANDARD MERCHANTABLE LENGTHS
Note: Each is divisible by 300mm and all measurements are shown in metres.

1.8	2.1	2.4	2.7	3.0	3.3	3.6
3.9	4.2	4.5	4.8	5.1	5.4	5.7
6.0	6.3	6.6	6.9	7.2		

Section Size

The following table outlines the common section sizes available. The nominal measurements are the unseasoned full sizes from which the seasoned sizes are derived;

TABLE 4
STANDARD SECTION DIMENSIONS

NOMINAL UNSEASONED TIMBER DIMENSION (mm)	ALLOWABLE DIMENSION (mm)	
	MIN. ACTUAL SEASONED SOFTWOOD	MIN. ACTUAL SEASONED HARDWOOD
25	19	19
38	35	30
50	42	40
75	70	60
100	90	80
125	120	105
150	140	135
200	190	185

Terminology

The following table outlines the most commonly used terms for timber with a particular size;

TABLE 5
CLASSIFICATION BY SIZE

SIZE		COMMON TERM	COMMON USE
THICKNESS	WIDTH		
under 20mm	up to 75mm	STRIP	May be used as a cover piece to a joint in sheet material, used as a planted stop to form a rebate, etc.
20 to 38mm	25 to 75mm	BATTEN	May be used as tile battens, timber diagonal braces for walls, as a ground attached to masonry,
10 to 38mm	75mm and over	BOARD	May be used as cupboard plinths, fascias, barges, flooring, linings, claddings, skirtings, window nosings, etc.
38 to 100mm	up to 150mm	SCANTLING	May be used for most framing timbers including bearers, joists, plates, studs, rafters, collar ties, noggings, etc.
38 to 100mm	over 150mm	PLANK	May be used for deep joists, hangers, deep rafters, hanging beams, timber frame lintels, etc.
over 100mm	over 150mm	BAULK OR FLITCH	May be used for structural beams, lintels, bearers, posts, framing for building hoardings, etc. A Baulk, Flitch or a Cant has squared sawn faces and may be re-sawn to form smaller members.

Manufacturing Terms

Sawn Timber

This is timber which has been converted from the log state into roughly squared useable pieces. Each face is sawn, rough sawn or fine sawn, using either a circular breakdown saw or a large band saw. Sawing takes place as soon as is practicable after the tree has been felled as it is easier to rip relatively green timber. Sawn timber is usually cut to the nominal size, i.e. 25, 50, 100, etc. , but this may vary by a few millimetres.

Dressed Timber

This is timber which has been passed through a planning such as a jointer or thicknesser to smooth a surface or surfaces. After seasoning and dressing the nominal sizes are reduced, i.e. 25mm nominal becomes 19mm finished size, 50mm nominal becomes 42mm finished size, 100mm nominal becomes 92mm finished size, etc.

Milled Timber

This term refers to timber which has been run through a milling or moulding machine to produce a decorative or functional face or edge. This may be in the form of tongue and grooved edges, a fluted or grooved face, a classical moulded edge, a rebate, a change of shape such as a quad or cavetto, etc.

Manufacturing Abbreviations

Abbreviations are often used in timber orders, specifications or material descriptions. The most commonly used are shown below;

TABLE 6
ABBREVIATIONS

ABBREVIATION	MEANING
R.S.	- Rough Sawn
F.S.	- Fine Sawn
D.A.R.	- Dressed All Round
D.D.	- Double Dressed or Dressed both sides
D.1.S.	- Dressed One Side
D.2.S.	- Dressed Two Sides
D.1.S.1.E.	- Dressed One Side and One Edge
* Other combinations of the above dressed sides and edges may be used.	

Timber Orders (Revision – refer to Basic Carpentry Skills - 1 for more detail)

To save time and confusion when ordering timber, the correct sequence of listing information should be followed, i.e.;

- Nominal size - section size stated in millimetres;
- Finish - state whether rough saw, dressed all round, moulded profile, etc;
- Seasoned or unseasoned - where applicable;
- Grade - where applicable;
- Species - state whether Oregon, Radiata pine or general Hardwood is required;
- Number of pieces - state the number of lengths required for each section size; and
- Length of pieces - state the length of the individual section sizes.

Note: It is preferable to state the longest lengths first to allow for quicker stack access at the timber yard. Each species of timber should be listed separately including rough sawn and dressed timbers.

Example 1:

100	x	50	R.S.	F8 Oregon	- 2/6.0, 3/5.1, 10/4.8, 5/3.6
100	x	25	F.S.	Western Red Cedar	- 10/4.5, 4/2.7
70	x	45	Milled	Radiata pine	- 9/5.7, 6/3.3, 25/2.7
75	x	38	D.A.R.	Meranti	- 7/4.8, 6/3.6, 8/2.1
135	x	40	R.S.	Seasoned F11 Hdw	- 6/5.4, 6/4.8
50	x	19	Pencil round	Meranti skirting	- 7/5.1, 4/4.5, 12/4.2
75	x	25	Bullnose	Radiata pine architrave	- 10/ sets

TIMBER DEFECTS

Timber is derived from trees which are exposed to the environment and all the harsh elements associated with it. Not only do trees have natural defects such as ribboned or wavy grain, knots, gum veins, etc., but they may also be subject to attack from insects and the elements, which may cause defects such as burls, splits from lightning strikes, twisted trunks from severe winds, etc.
Defects may also be due to poor stacking, poor seasoning or poor conversion, which require identification to avoid costly purchase of inferior, unusable framing and fixout materials.

Cup Shakes

This occurs when the fibres between two adjacent growth rings part, which may be as a result of poor drying techniques, or where large amounts of gum or resin between the growth rings has shrunk and crystallised causing a parting of the fibres. It occurs in the cross section of a log and looks similar to the damage caused by *Neotermes insularis* or 'ring-ant' termite which works, feeds and nests in the softer growth rings of a living tree.

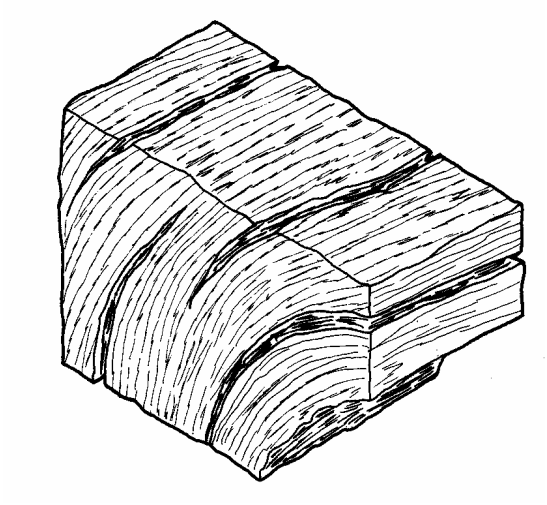


Fig. 9 Cup shake

Heart Shake

This is where the fibres between a medullary ray, which runs from the pith or heart of the tree to the outside of a log or section of timber, part causing a split.

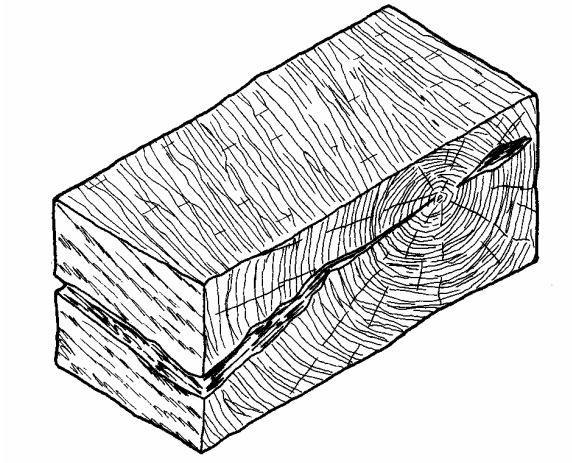


Fig. 10 Heart shake

Star Shake

This is basically a number of heart shakes radiating from the pith, which form a shape similar to a star.

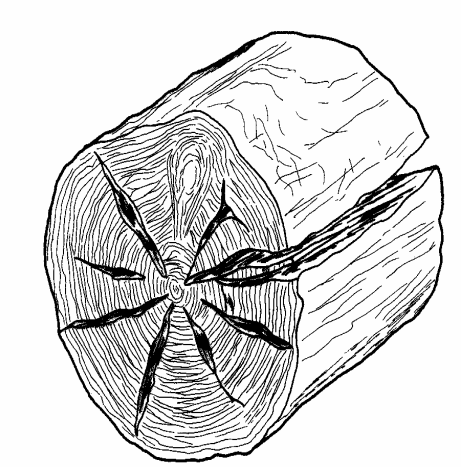


Fig. 11 Star shake

Gum Pockets

These occur where gum or resin forms between the vertical length of the growth rings and causes the fibres to part. They may be joined to the areas which form the cup shake.

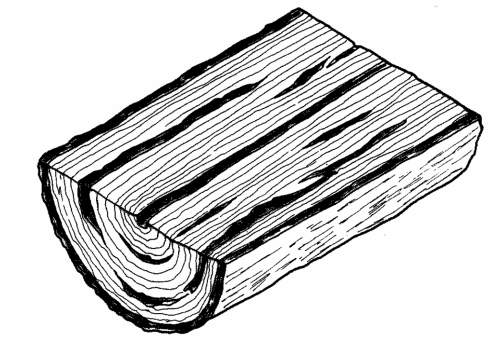


Fig. 12 Gum pockets

Felling Shake

This occurs when the tree is felled and it falls across a hard raised object, such as another felled tree or a rock, causing a fine fracture through the trunk. It may not even be visible during conversion of the log but it becomes obvious when seemingly solid timber separates in length, leaving two ends which fit neatly together. Sometimes wetting of the timber will reveal the fracture as it causes a darkened line to form at the point of fracture.

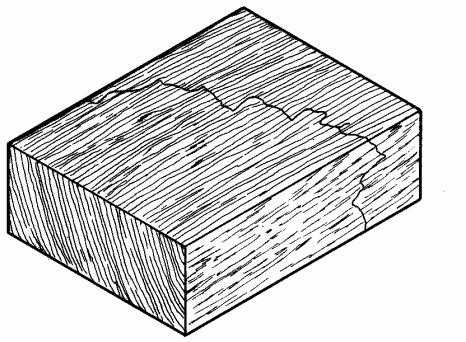


Fig 13 Felling shake

Knots

Knots form wherever a tree branch passes through the tree trunk. Spike knots occur where the branch has been cut in a lengthwise direction, commonly seen in sawn Radiata pine.
Live or tight knots are those which have inter-grown with the surrounding growth rings and are solid in the timber as can be commonly seen in Cypress pine flooring.
Other knots include Decayed knots, which are soft and affected by decay, Loose knots, which have not inter-grown with the surrounding growth rings and Pin knots, which are caused by small thin branches.

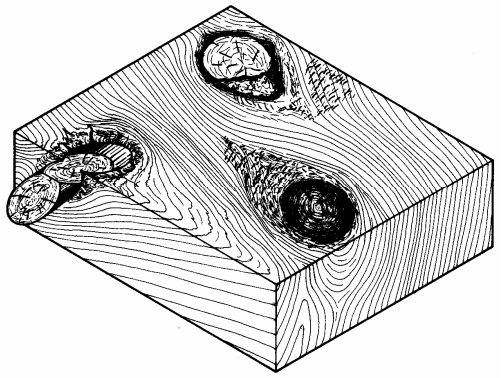


Fig. 14 Knots

Collapse

This occurs where the cells are flattened due to rapid and excessive drying out of free and combined water, which leads to uneven shrinkage.

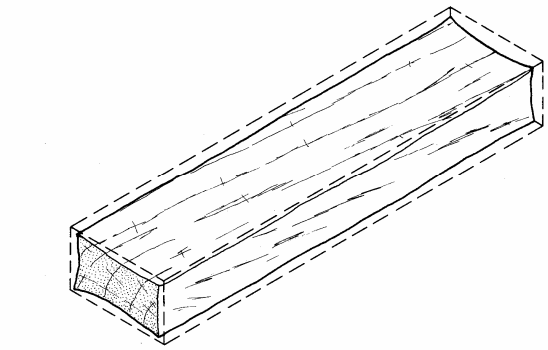


Fig. 15 Collapse

Cupping

Usually occurs where wide back sawn boards are subjected to excessive shrinkage along the long growth rings causing the edges to curl up along the length of the timber.

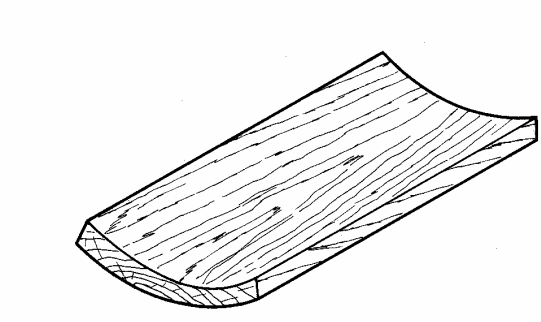


Fig. 16 Cupping

Wane

This is the absence of timber along part of the edge or where bark is still in tact due to converting cuts running too close to the outside of the tapering log.

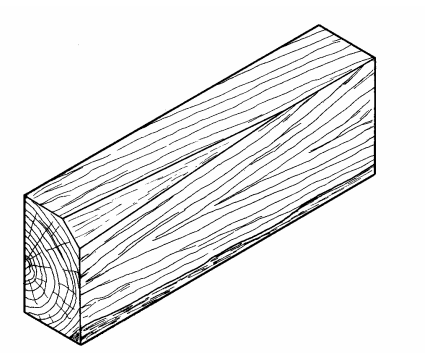


Fig. 17 Wane

Want

Similar to a wane but a larger section of the face is missing.

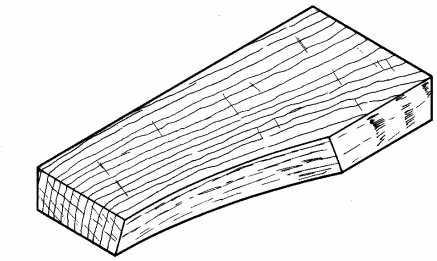


Fig. 18 Want

Grain Defects

This may be caused by the method of conversion or damage caused to the tree during it's growth, due to pest attack or severe environmental conditions. The grain may also be naturally wavy or interlocked as part of the timbers natural characteristics.

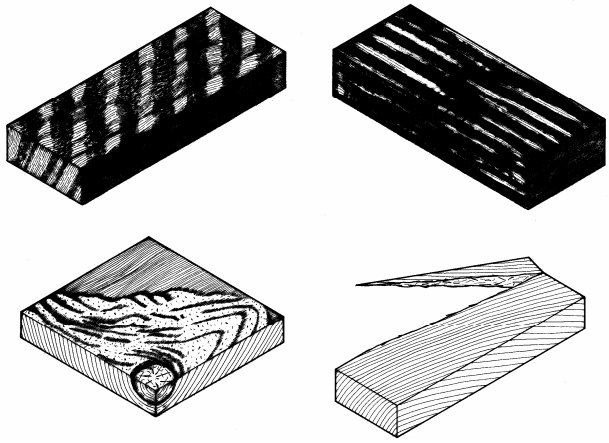


Fig. 19 Grain defects

Spring

This is where a length of timber is still straight along the face side but the edge has a curve or deviation. It is a common occurrence in scantling timbers and usually occurs during the seasoning process or may be due to poor stacking. Framing timbers may have to be cut or *crippled* to straighten them in length.

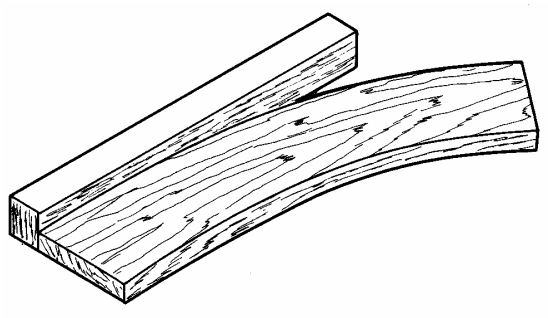


Fig. 20 Spring

Bow

This is where a length of timber is still straight along the edge but the face side has a curve or deviation. It is mainly due to poor stacking. Studs, rafters, joists, etc. may be straightened in position with the addition of noggings or trimmers, or being fixed off to another rigid member.

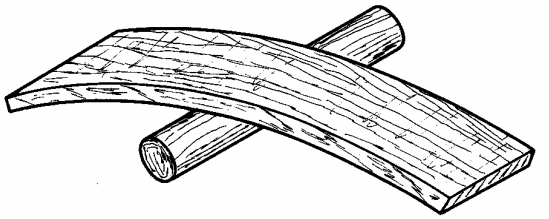


Fig. 21 Bow

Twist

This is where the timber has turned in it's length from a flat position. It is mainly caused by spiral or sloping grain drying unevenly during the seasoning process.

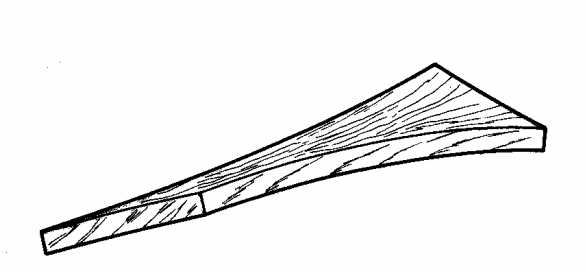


Fig. 22 Twist

TIMBER DECAY and FUNGAL ATTACK

Decay in timber usually occurs as a result of the combined presence of Oxygen, water and fungi. Fungi is not a plant, and is classified separately, as it does not have *chlorophyll,* and cannot manufacture it's food by *photosynthesis*. Instead, it feeds on *organic* materials by breaking them down and absorbing the nutrients. Fungi do not reproduce by producing seeds, but rather produce spores which may lay dormant in the ground or be transported by wind and rain.

Timber decay may occur in the open, such as external or internal fascia corners where leaking gutters have provided the moisture, or they may occur in protected areas, such as under suspended timber floors where a lack of air circulation and high moisture levels provide the right conditions.

Timber which has a moisture content level of 18% or above is susceptible to fungal attack and the resulting condition of decaying timber. Timber with levels below 18% will not develop fungal decay, therefore keeping moisture levels low and constant is critical in any building.

Terms Relating to 'Rot'

Wet Rot

This is the decaying of timber due to fungal attack caused by 'Brown rot fungi', 'White rot fungi' or 'Soft rot fungi'. Wet rot is the most common type of fungal attack in houses, fences, pergolas, decks or other building structures.

Note: Decay in timber will cease when the moisture content has reached 150%, or greater, as the timber is classified as being waterlogged and the fungi is no longer active within the timber.

Dry rot

This is a specific fungal growth, rare in Australia, which requires a high moisture content, i.e. above 30%, to establish. It also requires much cooler conditions to thrive and spread and is capable of spreading from the sub-floor to the roof space.

Decaying timber

This is timber which has a high moisture content, i.e. above 20%, and the fungi is usually visible and very active. The timber may still be quite sound inside and have it's original shape, but the outside may be soft.

Decayed timber

This is timber which has lost the high moisture content, has shrunk in size, is distorted and may be falling apart. The moisture content is below 20% and there is no visible sign of fungal growth.

Main Types of Timber Destroying Fungi

Brown Rot Fungi

This is also referred to as 'Brown cubical rot' due to the fact that the timber has broken along and across the grain, which results in cube-like shapes being formed. This rot only attacks the cellulose and leaves the lignin, which turns a characteristic brown colour.

White Rot Fungi

This is also referred to as 'White stringy rot' due to the white fibrous growth on the surface of the timber. This rot attacks both the cellulose and the lignin and leaves the timber with a whitish colour when decayed.

Soft Rot Fungi
This is also referred to as 'Carroty rot' as it leaves the timber with a cubical texture similar to brown rot but in much smaller sizes, like that of a carrot. It is an organism comprising of fungi and earth-borne bacteria, which tends to leave the timber a darker colour than it was before attack.

Dry Rot Fungi
This has the botanical name of '*Serpula lachrymans'* and is the only true type of 'Dry rot' fungi. Unlike the other common types of timber decay fungi it will not attack timber with a moisture content of less than 30% but can survive, once established, in timber with a moisture content of 20%. It also has the ability to grow over wet stone and brickwork to reach timber framing and can even grow up into the roof space from the sub-floor, if conditions are right. Also, it grows the quickest when temperatures are low, i.e. 20°C, whereas the other types grow their quickest at 25 - 30°C.

Note: The use of durable timbers, i.e. those which have a durability rating of Class 1 or 2, keeping moisture levels low and providing adequate ventilation are the best methods of preventing timber decay from occurring.

Rising Damp

Rising damp is caused by moisture in the soil being drawn up through masonry walling. The water brings 'salts' from the soil with it and as the water evaporates the salts crystallise and form a telltale white powder or mark on the walls. This is referred to as '*efflorescence*' and may cause severe damage to masonry by continually fretting away the surface as the salts crystallise and force out particles. Also, another telltale sign is blistering paint, especially obvious on rendered and painted walling. The moisture content in the masonry may also be transferred to timber components of the building structure and therefore lead to fungal growth, which inevitably results in timber decay.

Prevention
The best way to prevent rising damp is to correctly install a 'Damp-proof course' (DPC) at the appropriate level as the walls are being laid or before the slab is poured. The most suitable materials for use are those which do not degrade easily such as coated lead, coated Aluminium, coated copper and polyethylene plastic.

Repair

There are two common methods of repair used;

- *Physical* - Replace the damaged or broken down DPC with a suitable material which has a long life. This tends to be a very costly approach due to the time spent replacing the DPC in sections and the necessity to chop out the length of the bed joints in the masonry. If it is not carried out carefully the structural stability of the wall may be affected or movement in the wall may result.

- *Chemical* - This process is the most economical and least invasive approach as the walls are drilled at nominated centres and pressure injected with a mixture of silicones and Aluminium stearates (a salt of stearic acid) in a solvent fluid. When the solvent evaporates it leaves a waterproof barrier, thus creating a new Damp-proof course layer. Care must be observed during application and for several days after due to the evaporating solvents, which create a fire hazard.

The following details outline the danger zones and critical areas in and around a typical cottage;

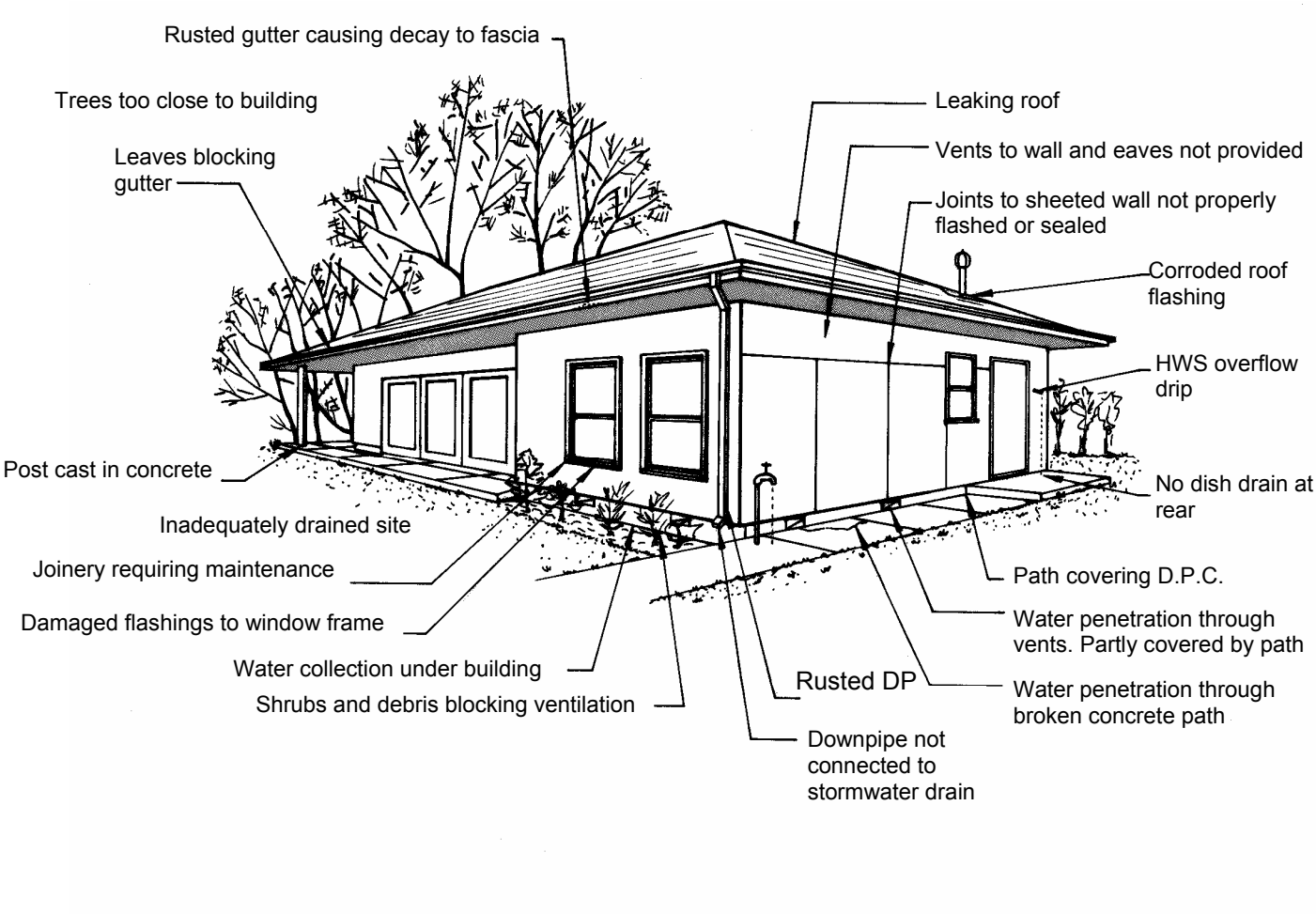


Fig. 23 Typical situations contributing to Timber Decay

The main factors which contribute to dampness in a building and building timbers are;

- Leaking taps against walls;
- Leaking drainage pipes in the sub-floor area;
- Poor sub-floor ventilation and cross ventilation;
- Leaking stormwater pipes;
- Rusted or leaking downpipes and gutters;
- DPC's degraded or non-existent;
- Leaking appliances such as dishwashers and washing machines;
- Leaking shower recesses;
- Rain water running freely in sub-floor areas;
- Cracked or broken roof tiles.

Note: Building maintenance is an important ongoing process which tends to be neglected on many buildings and eventually leads to timbers decaying, a shortened material life and very expensive repairs.

TIMBER PRESERVATIVES

Some timbers have a natural resistance to insect and environmental attack, such as White Cypress pine, Tallowwood, Ironbark, Turpentine, Grey gum, etc., and many have a poor resistance to attack, such as Mountain ash, Douglas fir, Radiata pine and most other pine species. To improve the durability and longevity of timber there are several materials and methods of application which may be used.

Impregnation
Pressure treating green timber is one of the most successful and commonly used methods of timber preservation. The use of CCA salts (copper sulphate, chromium sulphate and arsenic pentoxide) under vacuum pressure, approx. 1400 kPa for sixty minutes, is one of the best known methods of increasing a timbers durability. The pressurised vacuum created in large tanks allows the chemical salts to be drawn into the timber cells and mix with the free water inside. When the timber is seasoned and the free water dries out, leaving the salts to act as an insecticide and fungicide, which will deter insects, such as termites and borers, Brown, White and Soft rot fungi.. These treated timbers are usually recognised by the characteristic green copper colour, as seen in treated Radiata pine used for '*Koppers Logs'*.

Surface Treatments
There are many propriety products on the market to seal, soak and treat timber to prevent attack from the effects of weathering and attack from fungi. These may be in the form of paints and other liquids, which are applied by brush, roller or spray gun. Examples of these are as follows;

- *Linseed oil* - This is a natural oil which dries out completely and is absorbed into the timber. It provides a good base for covering coats of paint or may be used raw to seal internal and external joinery items. It dries with a flat finish and is not a preferred joinery finish as it tends to *yellow* the natural timber colour.

- *Tung oil* - This is also a natural oil and may refer to any oil extracted from trees. It is also called 'Wood-oil' and may come from the East Indian Satin wood, the seeds of the Chinese Oil-tree or Varnish-tree. Similar to Linseed oil it dries out on timber and provides a good base for top coat paints and it too tends to yellow the timber if left raw.

- *Safflower, Sunflower and Soya Bean oil* - These are semi-drying oils which do not yellow timber. They tend to be used as a base for gloss alkyd enamels. Other oils used may include Cottonseed, Coconut and Rapeseed oils, but these are classified as non-drying and have limited use.

- *Natural resins and Gums* - These tend to be used for internal joinery and furniture rather than external or in-ground use. They comprise a variety of substances, such as those extracted from pines, like Huon pine or Shellac, which is derived from the excretions of the Lac beetle.

- *Primer* - The main function of a primer is to form a strong bond between the timber surface and the top coats. It has a natural water repellent nature and seals the pores of the timber. Older types of primer used lead, which has since been banned due to it's toxicity, but the modern versions use oils mixed with pigments to make 'White' or 'Pink' primers. They are available in water and oil based preparations and may be applied to fascias, weatherboards, window and door frames, and external structures prior to undercoat and top coat application.

BORING TOOLS

Boring Tools

There are many types of hand boring tools used to form holes and circular recesses for nails, screws, bolts, patent fixings or to simply remove waste material so a fitting may be placed, such as a door lock. Drill bits are designed for use on softwood, hardwood, steel, concrete and masonry, etc., although manually operated boring tools are generally limited for use on timber and very light steel.

Bradawl

This tool is used for making small pilot holes for screws or nails to prevent splitting of the timber. It has a thin steel rod, flattened to a cutting edge at one end and fitted with a handle at the other. It works by pushing, by hand and not hit, the cutting edge into the timber across the grain and twisting it back and forth until the desired depth is reached. It is small enough to fit into a nail bag pouch for quick access when carrying out-fix out type work.

Fig. 24 Bradawl

Hand drill or *Eggbeater*

The hand drill is used to drill holes in thin material and through joints of mouldings, to prevent splitting, when they are to be nailed or screwed. Some drills have a range of speeds due to the set up of the gears but generally the speed is governed by the operator. The chuck usually has three self centering jaws and can be used with round shank twist drills up to 6mm diameter, to give a quick clean hole.

These drills are not used often but are very handy when there is only a small number of holes to be drilled, there is no power available for an electric drill or the battery goes flat on the battery drill.

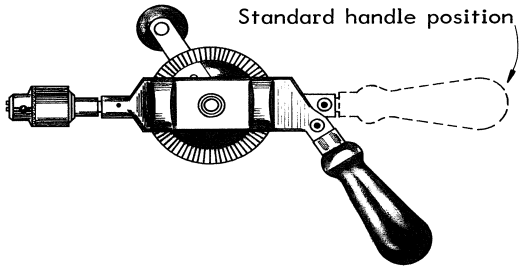


Fig. 25 Hand drill

Brace and Bit

The ratchet brace is a very useful tool for boring a variety of size holes in a variety of situations. It may also be fitted with a screw driver bit to place or remove screws. It may be very useful in tight and awkward spots or where only a couple of holes are required. The bend in the handle area gives good leverage when using large bits and the ratchet allows half turns without withdrawing the drill.

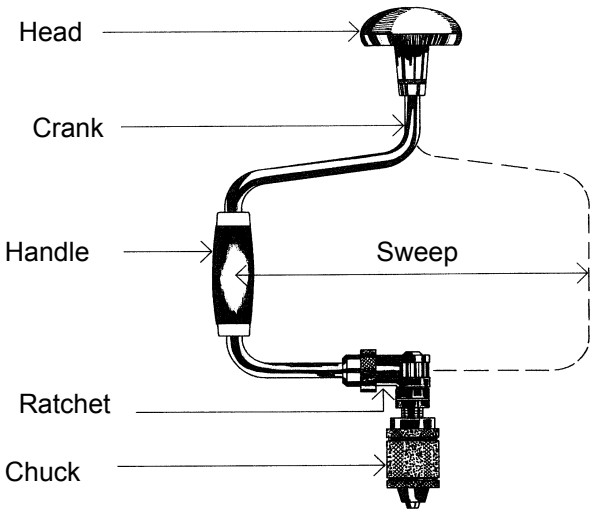


Fig. 26 The ratchet brace

Twist bits

There are two types;

- With spurs for use on softwoods to slice through the grain on the surface to prevent tearing, eg.
  Radiata pine, Western red cedar, Slash pine, etc.
- Without spurs for use on hardwoods to bight through the tough surface, eg. Tallowwood, Brush box, Iron bark, etc.

Other bits available are the centre bit, expansion bit, countersink bit and screwdriver bits.

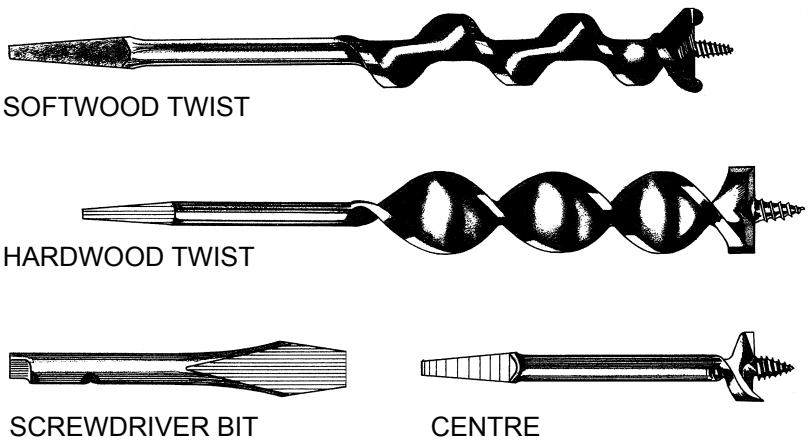


Fig. 27 Twist bits available for use with the Brace

CUTTING ROUND SHAPES

Hole-saws

Hole-saw sets are available with circular blades, which will cut to a depth of 13mm to 45mm when boring with a power drill, from one side. Blade diameters range from 19mm to 63mm and are available in a variety of combinations, which include 4, 6 and 7 piece sets, with one of the pieces being a 6mm mandrill. The blades are made from high speed steel and used for cutting timber, wallboard, fibreglass, sheet metal or light section mild steel. A common use of this saw is for preparation of a hole in a door, to fit a cylinder type lock or passage set, by boring from both sides to avoid splitting out the face.

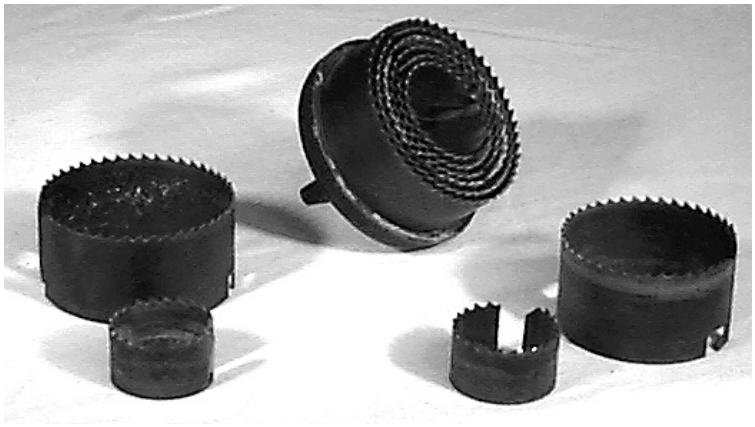


Fig. 28 Hole saw sets

High Speed Welded Edge Hole saws

These high speed bimetal saws are made from a hardened steel cutting edge welded to a tough alloy steel body. This saw may be used by many tradespersons for cutting a variety of materials from timber and plastics to steel, brass, bronze, cast iron and aluminium.

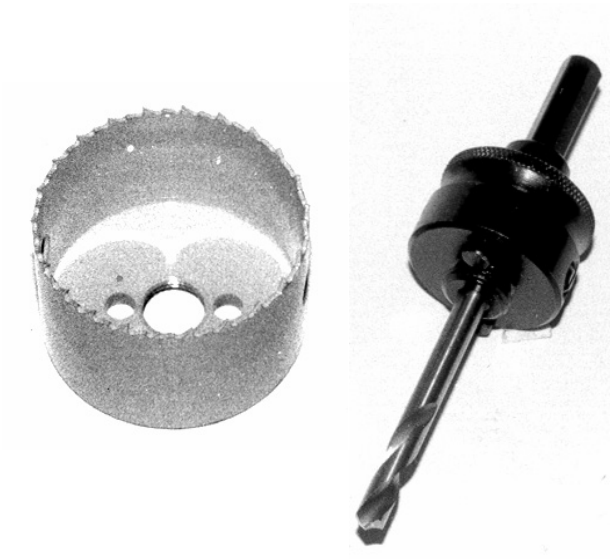


Fig. 29 High speed welded edge Hole saw

SPECIAL HAND PLANES and SAWS

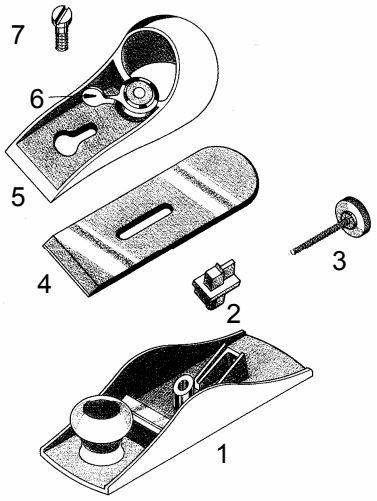
PLANES

As previously stated in Basic Carpentry Skills - 1, planes are cutting tools used to form plane flat surfaces and reduce timber in section size. They include the common bench planes such as the timber German jack, steel jack, trying or jointer and smoothing planes. There are however special planes which have been adapted for smoothing and shaping surfaces, shooting end grain, forming mouldings, rebates, grooves, trenches, etc. This group of special planes includes the following:

Block plane

This is a small metal single iron plane in which the cutting iron is set at a lower angle than that of the common planes. The cutting iron of the common bench planes is set at 45° in the body of the plane, whereas the usual angle of the block plane cutter is 20°. More specialised block planes have the cutter set at 12°.

The plane is designed for planing *end grain* as the low angle of the cutter enables it to be placed in a position reverse to that of the cutter in the common bench planes, therefore the bevel is placed uppermost allowing bearing to be obtained immediately behind the cutting edge. Such a close bearing surface supports the cutting edge and assists in preventing *chattering*. The block plane may be held in one hand with the other being free to hold the work. The usual width of the blade is 42mm sharpened straight and square across the end of the blade.

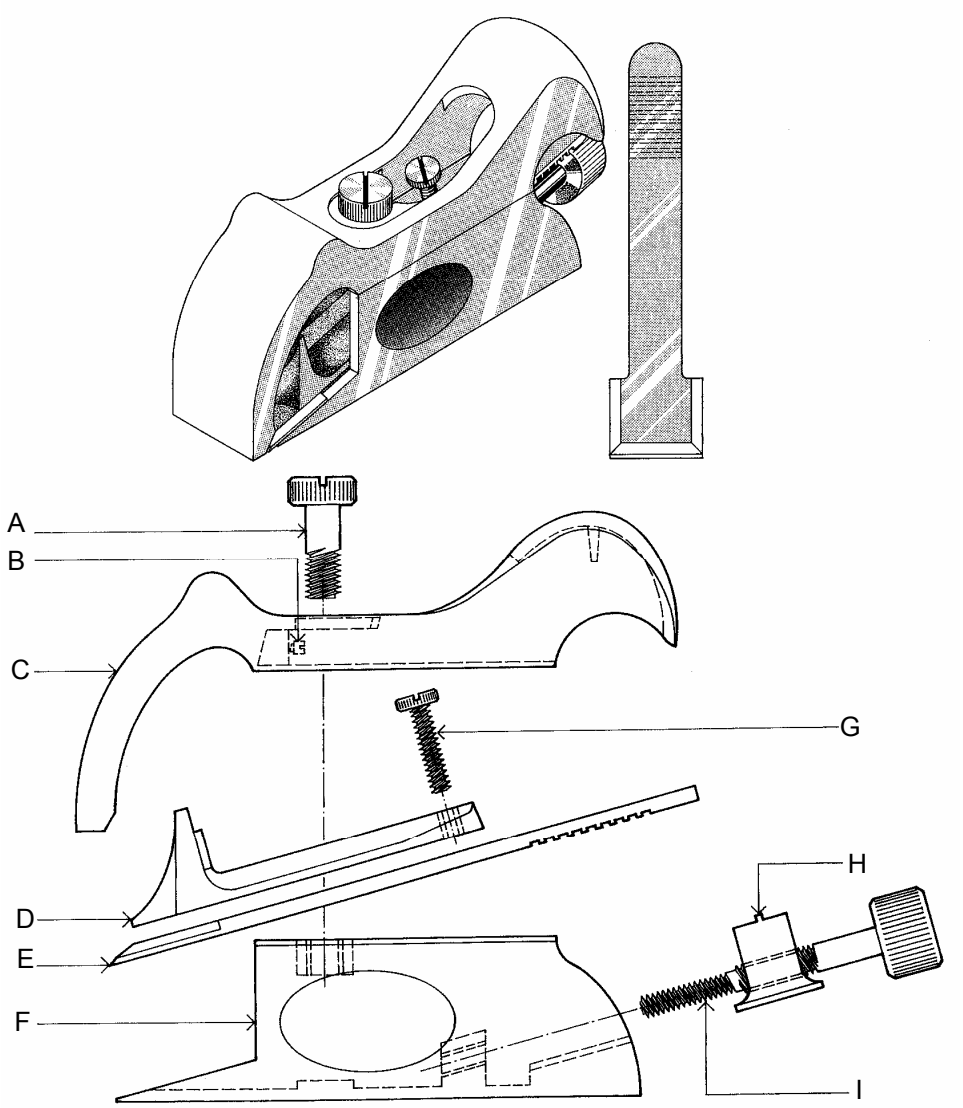


ITEM	NAME OF COMPONENT
1	Body
2	Cutter adjusting nut
3	Cutter adjusting knob or screw
4	Cutter or blade
5	Lever cap
6	Clamp lever
7	Lever cap screw

Fig. 30 Detail of a Block plane

Shoulder rebate plane

This is a type of rebate plane, similar to a bullnose rebate plane, used to finish off rebates and other narrow surfaces close up to stops or abutments. The cutter in this plane is set close to the front end and is set face down, so that it may have a bed or support close up to the cutting edge.

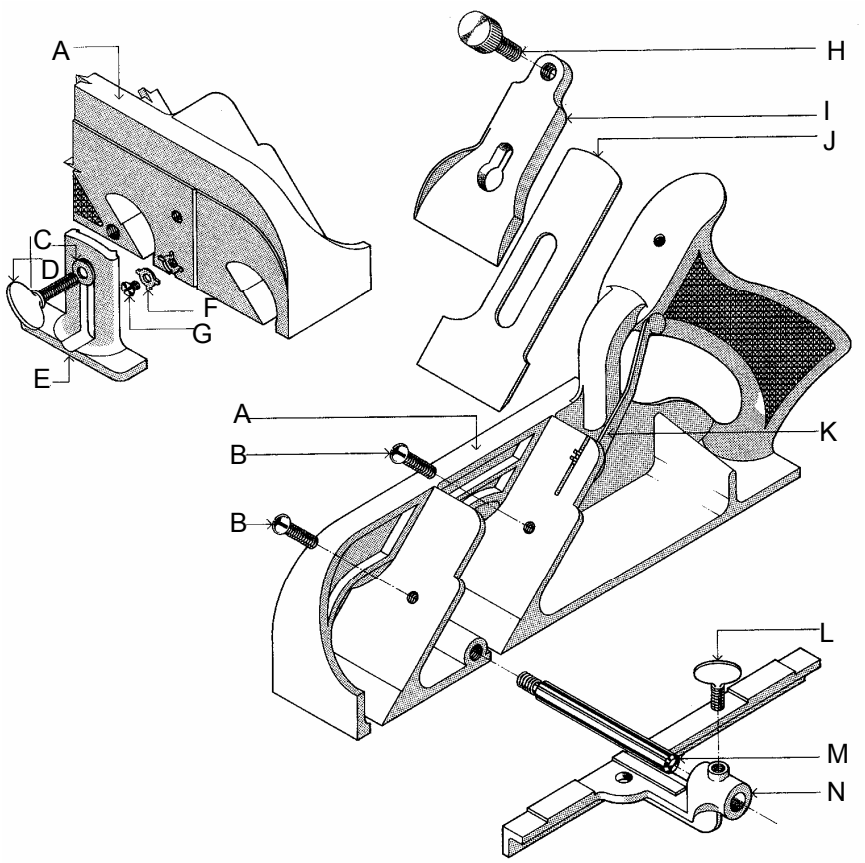


ITEM	NAME OF COMPONENT
A	Nose locking screw
B	Mouth adjusting screw
C	Bullnose or nose
D	Lever cap
E	Cutter or blade
F	Body
G	Lever cap screw
H	Cutter adjusting nut
I	Cutter adjusting screw

Fig. 31 Shoulder rebate plane

Duplex rebate plane

This plane ranges in size from 230mm to 330mm long and has two cutter positions, hence the name *duplex,* meaning two. The cutters are usually 55mm wide and the plane is used to cut and clean up rebates on the edge of timber. It may be used to cut a rebate in the back of an architrave to allow proper fitting over wall linings where they project beyond the edge of the window reveal or door jamb material.

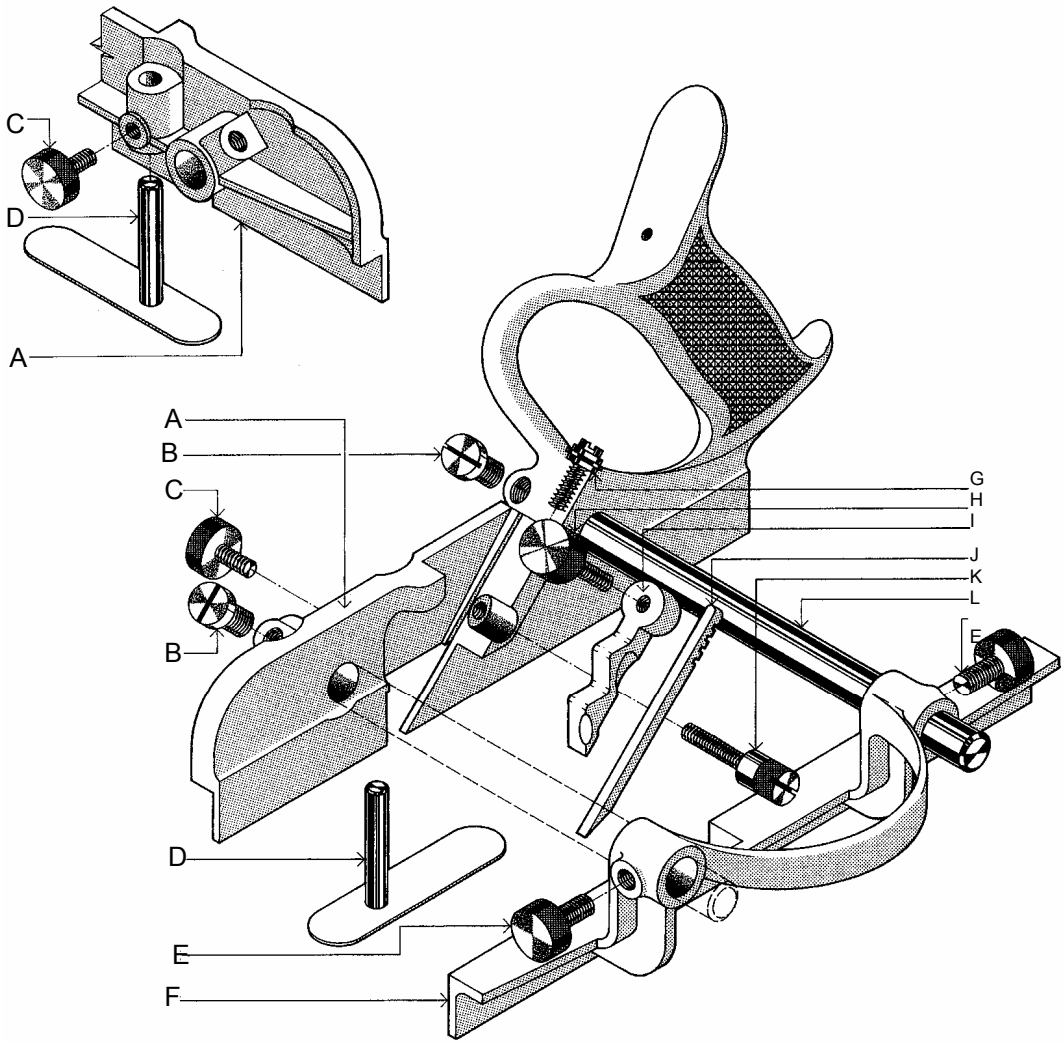


ITEM	NAME OF COMPONENT
A	Body
B	Lever cap screw
C	Depth gauge washer
D	Depth gauge screw
E	Depth gauge
F	Spur
G	Spur screw
H	Lever cap knurled screw
I	Lever cap
J	Cutter or blade
K	Cutter adjusting lever
L	Fence thumb screw
M	Fence arm
N	Fence

Fig. 32 Duplex rebate plane

Plough plane

This plane may be used to cut narrow grooves on the face or edge of timber. This is to allow for thin panels to be inserted for framed joinery doors, create a groove for a tongue to allow jointing of wide timber, cut one or multiple shallow grooves across the width of a step ladder tread, etc.



ITEM	NAME OF COMPONENT
A	Body
B	Body arm set screw
C	Depth gauge knurled screw
D	Depth gauge
E	Fence adjusting knurled screw
F	Fence
G	Cutter adjusting screw
H	Lever cap screw
I	Lever cap
J	Cutter
K	Cutter clamping screw
L	Fence arm

Fig. 33 Plough plane

Hand Router

This plane is used for levelling the bottom of wide grooves, housings and trenches to a set depth. It has a sole plate with a knob type handle on either side and an adjustable depth cutter, which is euphemistically referred to as '*an old man or woman's* tooth'. The adjustable depth gauge set at the front should be set flush with the underside of the sole to prevent tipping when used on wide trenches.

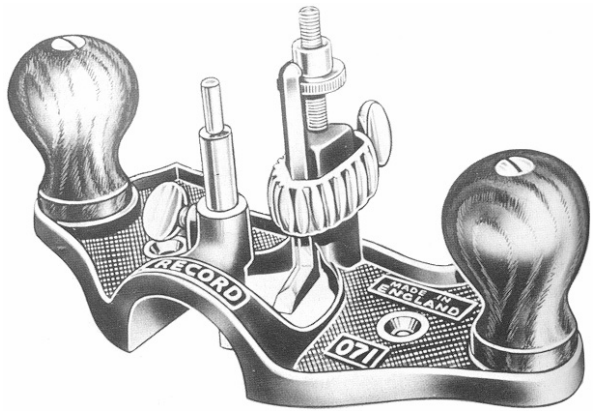


Fig. 34 Hand Router

Spokeshaves

They may be made of timber or metal and are either classified as 'flat' or 'round' due to the shape of the sole and their intended use. The flat face spokeshave is used for planing *convex curves* and the round face spokeshave is used for *concave curves.* They may have single or double adjusting screws fitted to the cap iron to allow adjustment of the cutter. They must be held very firmly when used to avoid *chattering* and they may be pulled or pushed to create the cut, but always in the direction of the grain.

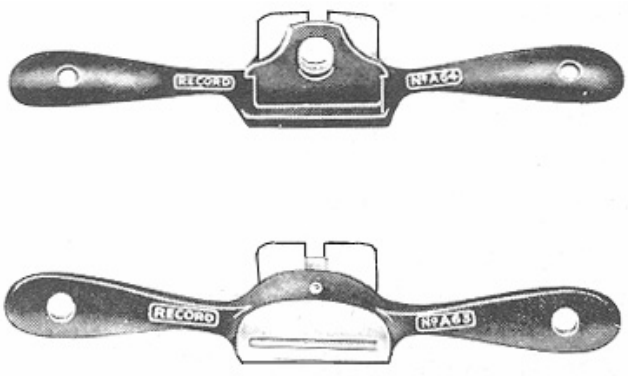


Fig. 35 Spokeshaves

Note:

There are also many specialist type solid timber bodied planes which will do the same job as the metal planes mentioned here. They are no longer readily available for purchase but may be picked up at second hand or antique shops. It should also be noted that many of these timber planes were made from a dense, aged pine timber and therefore may be found in very poor condition as it is very susceptible to *Anobium punctatum* borer attack, also known as 'Furniture beetle'.

HAND SAWS

As previously stated in Unit 1, hand saws are cutting tools used to cut along or across the grain to reduce timber and sheet material to length, width or thickness with the common hand saw types being *cross cut* and *rip*.
There are however special saws used for cutting holes and curves in timber and others which have been adapted for cutting materials other than timber. This group of special saws includes the following:

Pad and Compass saws

These saws are used for cutting internal and external curves and holes. They have narrow blades which taper either to a sharp point or to a square end.
They do not have a frame and are therefore not restricted in use, compared to coping and fret saws.
They also have provision for blade disengagement so that various size blades can be quickly fitted or replaced. The smaller straight handle types are usually called *pad saws* and other larger types are usually called *compass saws*. Each type is manufactured as a nest of saws, usually having three blades of a different size.

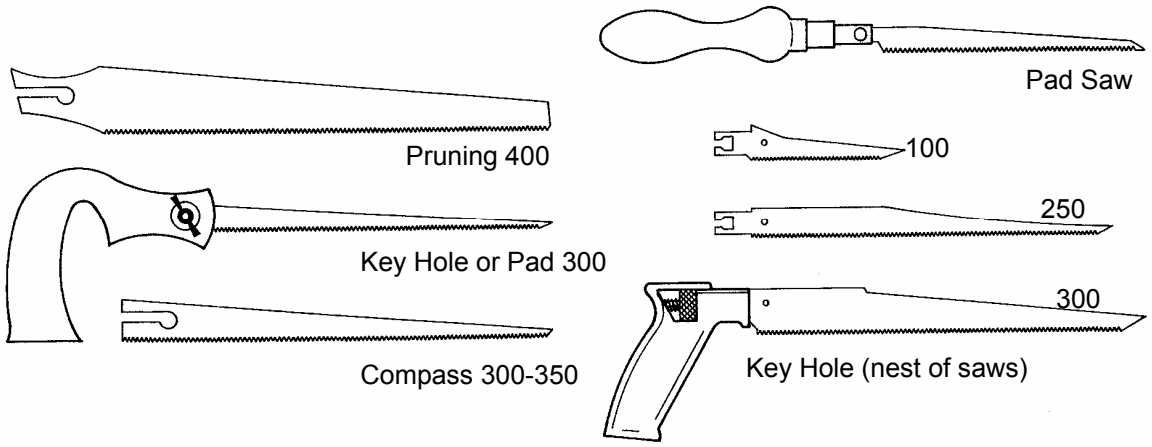


Fig. 36 Pad and Compass saws

Coping saw

This is the best all-round saw for cutting curves in thin material and *scribing* mouldings. The cut can be started either from the edge or anywhere inside the work. The depth of cut depends on the distance between the blade and the back of the saw. The blade can be rotated through 360°. It is fitted in the frame with the teeth facing away from the handle. The blades cannot be re-sharpened and are discarded when they become blunt. The saw is held with the handle in a horizontal position and cut with a forward stroke.

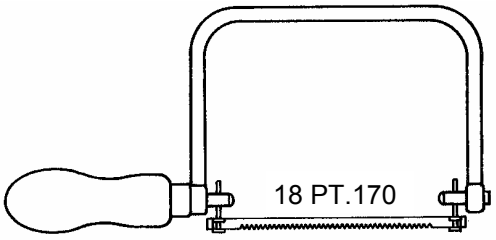


Fig 37 Coping Saw

Fret saw

The fret saw is used mostly in model making because it is able to cut intricate curves in thin ply, thin solid timber and some thin acrylic materials. The blade is fitted in the frame with the teeth facing downwards, (towards the handle) as the cut is made on the downwards stroke, and the saw is held with the handle in a vertical position. The blade angle is not adjustable because the blade is thin enough to be used in any direction.

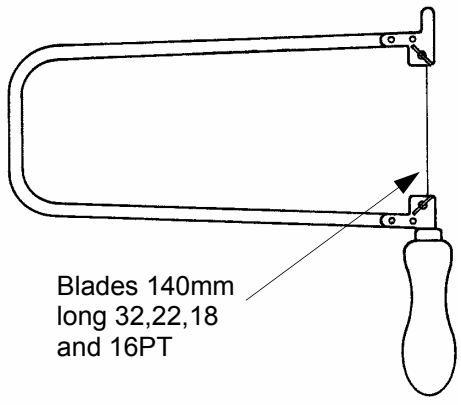


Fig. 38 Fret saw

Bow saw

The Bow saw consists of a narrow steel blade fixed to brass bushes and set screws, attached to revolving handles. The blade is held taught by the tension put into a twisted string attached to the top of the arms. A light spreader or cross bar across the centre holds the timber slip or wedge from springing back, keeping the arms of the saw apart. The saw is used to cut large curves in thicker timber than that of the coping saw. It must be remembered that the blade should be kept square to the face of the timber to avoid twisting, which will create a bevelled cut and may also cause the blade to snap.

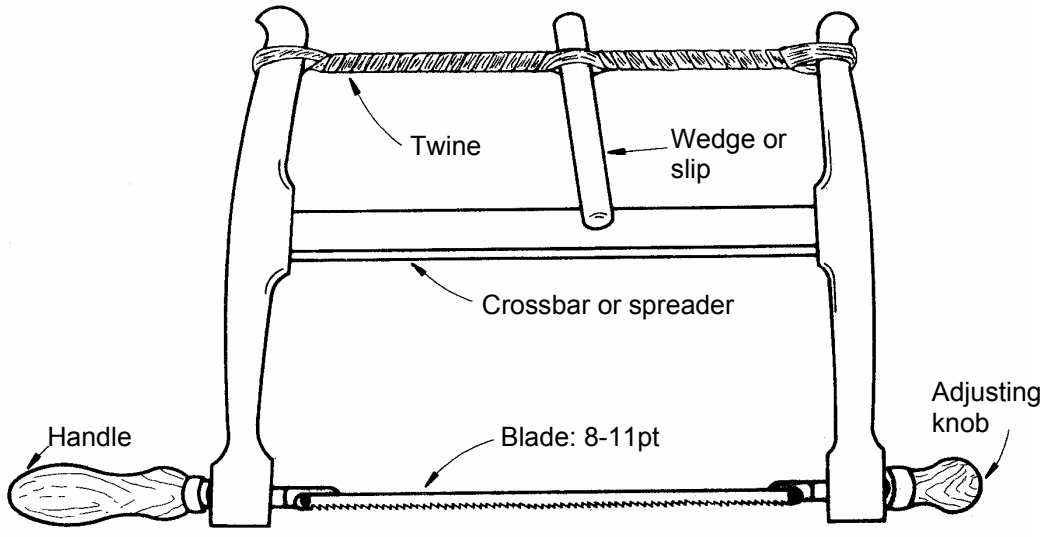
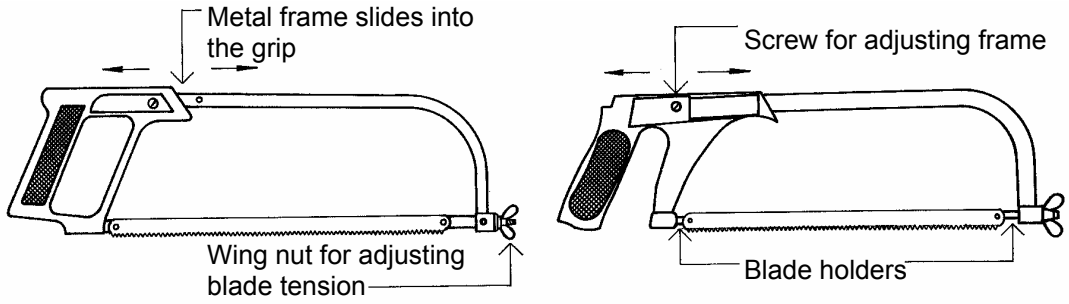


Fig. 39 Bow saw

Hacksaw

This is a general purpose saw having a detachable blade in a metal frame, with open or closed pistol grip handles. Hacksaws are used to straight cut materials such as sheet or solid metal, plastic and acrylic materials. The blades are flexible or rigid high speed steel with the option of fine teeth (24 to 32 teeth per 25mm) or coarse teeth (14 to 18 teeth per 25mm).
The blade fits into the frame with the teeth pointing away from the handle. For best results always choose a blade which allows at least three teeth to be in contact with the metal at the same time while cutting.



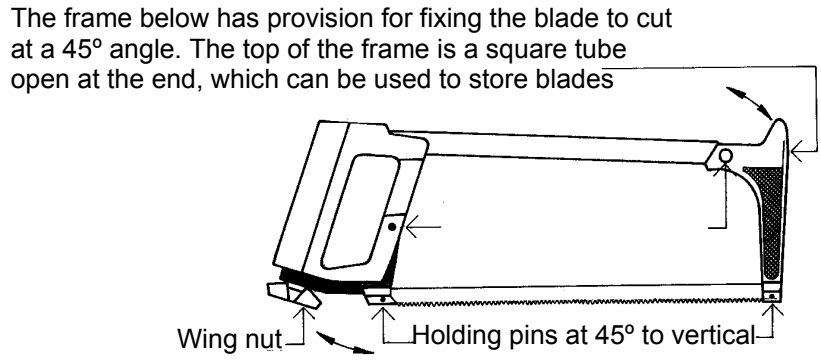


Fig. 40 Hacksaws

MAINTENANCE OF SAWS

Saws should ideally be kept in a saw bag with teeth protection, such as a timber strip, split plastic hose or split plastic conduit, or be kept hanging up in a position where the teeth will not be damaged. The screws in the timber or plastic handles should be tight at all times and when the saw is not in use the blades should be coated with a very light smear of oil, using a home-made oil spreader, to prevent rusting. Saws also need to be sharpened frequently to allow for optimum performance with the teeth requiring setting after three or four sharpenings.

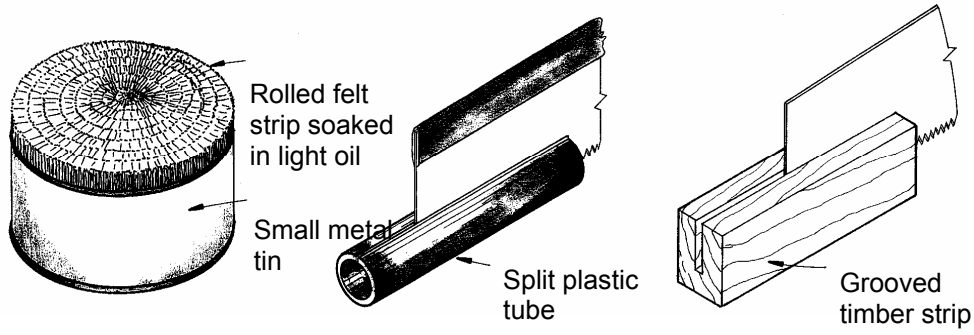


Fig. 41 Home-made oil spreader and teeth protector

SAW SHARPENING

The sequence of operations to be followed is set out below:

1. Topping or Breasting
2. Shaping
3. Setting
4. Side filing when necessary
5. Sharpening or Filing
6. Side dressing

STEP 1 Topping or Breasting

The purpose of this operation is to bring the teeth to a uniform height by placing the saw in a saw vice and running a flat file, held square to the blade, across the top of the teeth for the full length of the saw until all the teeth have been touched. There should be a slight *camber* along the length of the top of the teeth to prevent kicking during use, which is usually caused by a blade with a hollow.

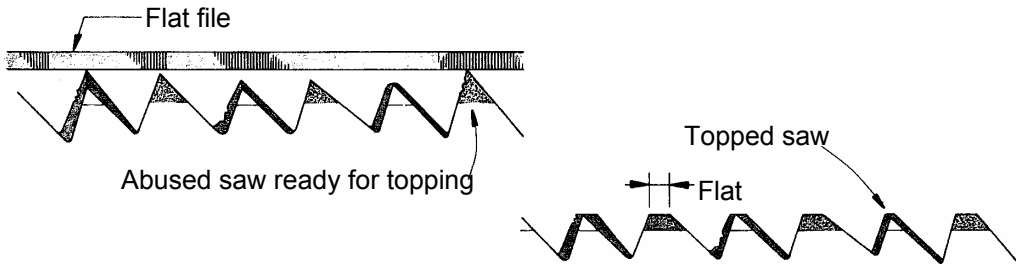


Fig. 42 Topping or Breasting

STEP 2 Shaping

After the saw has been topped, the gullets or valleys formed between the teeth will be of unequal depth which will create teeth of unequal size. Using a triangular slim-taper file, shape the teeth by filing both the front and back of each tooth as required, keeping the file horizontal and at right angles to the saw, until the desired constant shape is created.

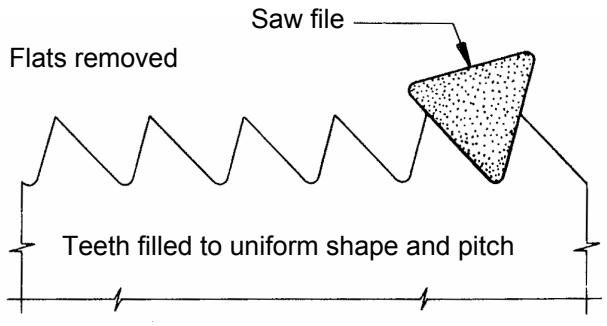


Fig. 43 Shaping the teeth

STEP 3 Setting

Setting consists of springing or bending over the upper half of each alternate tooth in the opposite direction to allow the saw to create a *kerf* just wide enough for the blade to pass through without binding or jamming. This process is carried out, while the saw is in the vice, using an adjustable *saw set*. The saw set usually has a tapered disc with the number of teeth per 25mm marked on it so it may be set to suit a variety of saw and teeth sizes.

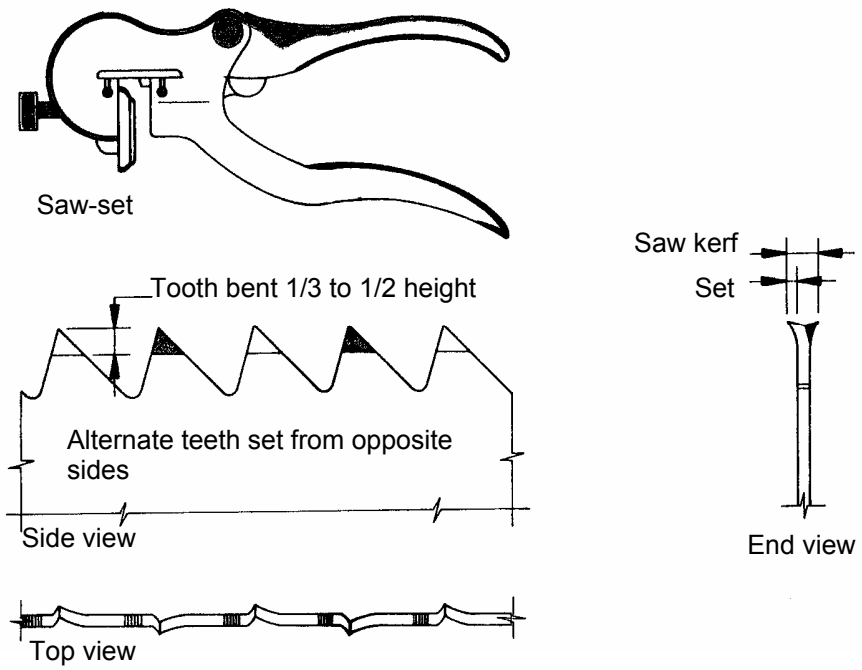


Fig. 44 Saw set and setting process

STEP 4 Side filing

After setting, a smooth file or oil stone may be run along the outside of the teeth on both sides to remove any irregularities caused during the setting process.

STEP 5 Sharpening or Filing Crosscut saws

a. Place the saw in the vice with the handle at the right side and the teeth approx. 10 to 12mm above the jaws;
b. Start from the handle end of the saw selecting the first tooth with its tip pointing towards you. Place the file in the gullet to the left of this tooth at 90° to the blade and then swing the handle approx. 30° to the left, which will create an angle of approx. 60° on the diagonally opposite side;
c. Keeping the selected angle constant for all teeth, take three or four light cuts by pushing the file away from you.
d. File each alternate tooth for the full length of the saw on one side, then reverse the saw in the vice and start at the opposite end to the handle and file the remaining teeth;
e. Only remove half the flat top on each tooth when filing on the first side, then remove the other half when the saw has been reversed to file the other side;

Sharpening or filing Rip saws

The procedure is the same as for crosscut saws except for the angle. In this case the file is held at 90° to the blade vertically and horizontally. In some cases the file may be swung up to 5°

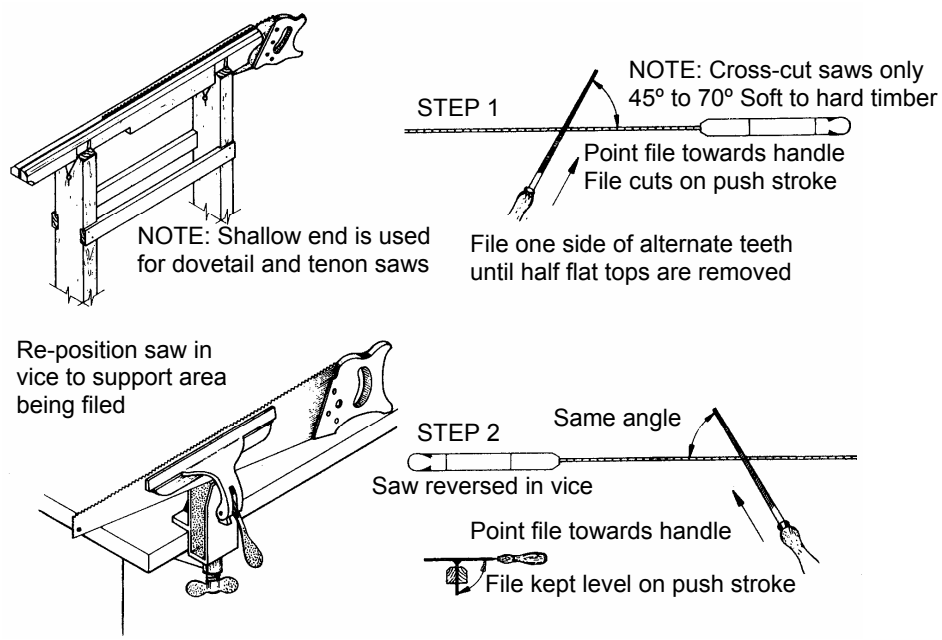


Fig. 45 Sharpening procedure

STEP 6 Side Dressing

After the sharpening procedure is complete, run an oil stone lightly along the outside of the teeth once on both sides. This will remove any burr created by the filing.

FILES

A three-cornered file is used, which has sides at 60°. This will ensure the teeth formed will always be at 60°. The 'slim-taper' file is the most commonly used but regular, taper, slim and extra slim are available. Size and use of files as follows:

TABLE 1
Files and uses

FILE	PITCH	No. OF TEETH PER 25mm	SAW	LENGTH
225	8.0	3.5	Rip	650
200	7.0	4 - 5	Rip	650
175	5.5	5.5 - 6	Rip & Hand	650
150	5.0	6.5 - 7	Hand	650
135	4.0	7	Hand	650
125	3.5	8 - 9	Hand	650
110	3.0	10	Panel	550
100	2.0	12	Tenon	300
75	1.0	14 - 16	Dovetail	250

COMMON TIMBER JOINTS

HOUSING JOINTS

Housing joints are used in general construction, joinery and cabinetmaking. The most common types include *through*, *stopped* and *side* housings but there are others, which are used for specific purposes. These include the *shouldered, dovetailed* and *end lap* housings.

Shouldered housing

A shoulder is formed on the end of the horizontal member so that the length of all pieces will all be cut exactly to the shoulder length. The depth of the housing or the length of the tongue is not as important as the shoulder to shoulder length. It may be used to construct book cases or built-in shelving.

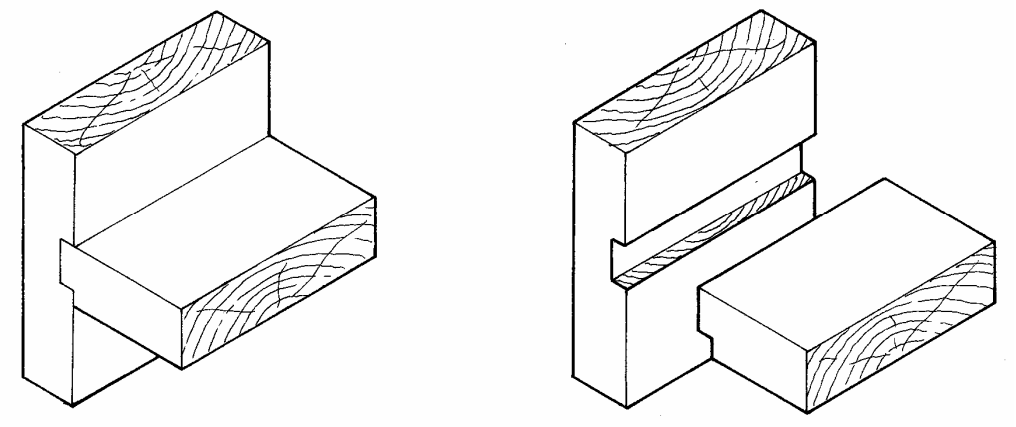


Fig. 46 Shouldered housing

Half dovetail housing

This type of joint is used where strength is important and it is not desirable to fix with screws or nails, for appearance reasons. Once glued and cramped this joint is very suitable for exposed sided cabinet or shelving work, although time consuming to prepare.

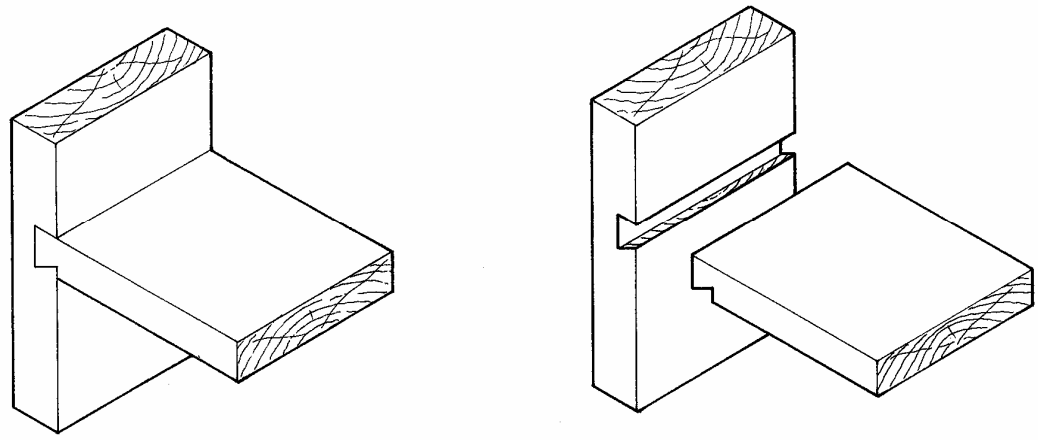


Fig. 47 Half dovetail housing

End lap housing

This joint is typically used for the construction of boxes, trays, carry-alls, etc. where the joint is to be glued and nailed or screwed. Where additional strength is required and appearance is important, a lapped dovetail joint may be used instead of the end lap joint.

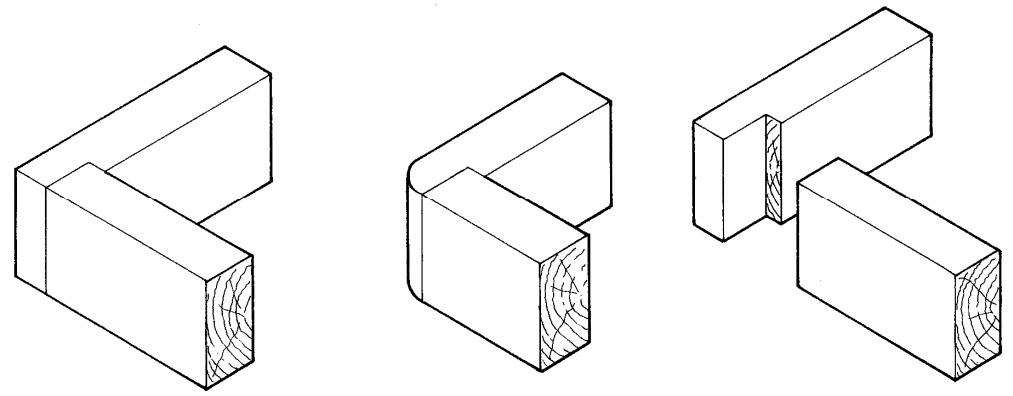


Fig. 48 End or corner lap housing

SET OUT AND CONSTRUCTION OF THE JOINTS

A similar process is involved in setting out all housing joints. The following steps may be applied to any of the above joints with only a slight variation for each individual joint.

Construction of a Through Housing joint

STEP 1. Select and mark the face side and edge on each piece.
Mark the position and width of the housing on one piece, using the end of the other piece as the template, on the opposite side to the face mark.
Square these marks across the width of the timber and down both edges.

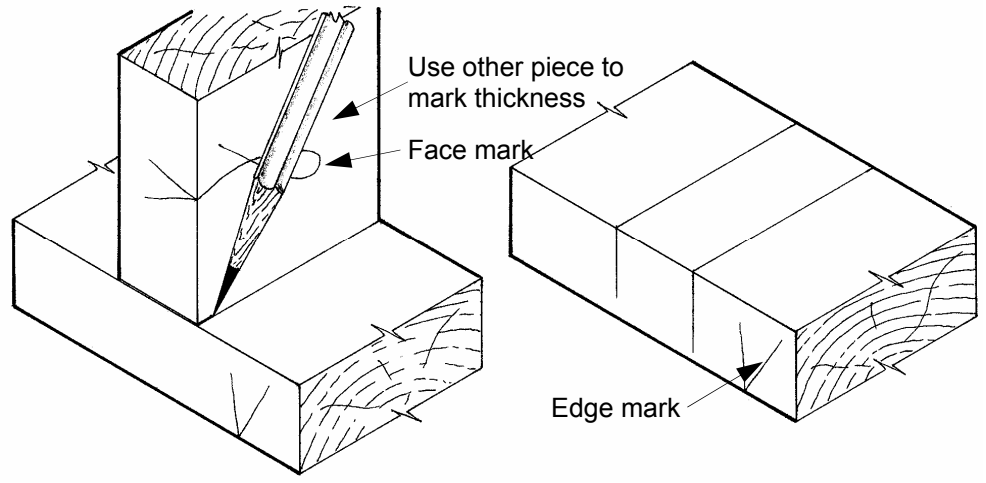


Fig. 49 Setting out the joint

STEP 2. Mark the depth of the housing on one edge.
Set a marking gauge to the depth mark from the face side and gauge a line on both edges.
Place a cross or other suitable mark on the waste area to be removed so that the waste side cannot be mistaken.
***Note**: The gauge is always set from the face side so that any subsequent joints will have the same amount left on if the timber used happens to vary slightly in thickness. This ensures that the overall frame will remain parallel throughout its length.*

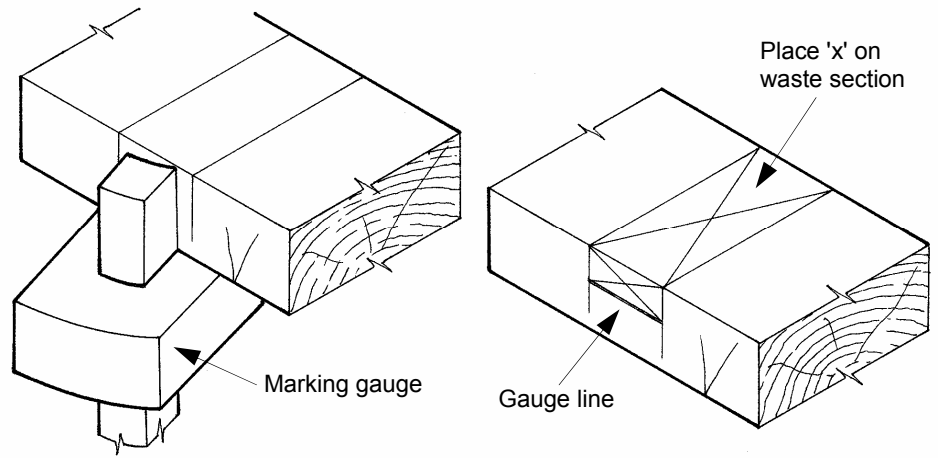


Fig. 50 Gauging depth of housing

STEP 3. Using a crosscut saw, cut along the face side marks, on the waste side, to the depth marked on the edges. To allow easy removal of the waste an additional relief cut may be made in the centre of the housing. More than one relief cut may be necessary on wide housings.
***Hint:** A temporary timber fence may be cramped to the edge of the cutting lines, on the side which remains, to ensure a straight saw cut along the line.*

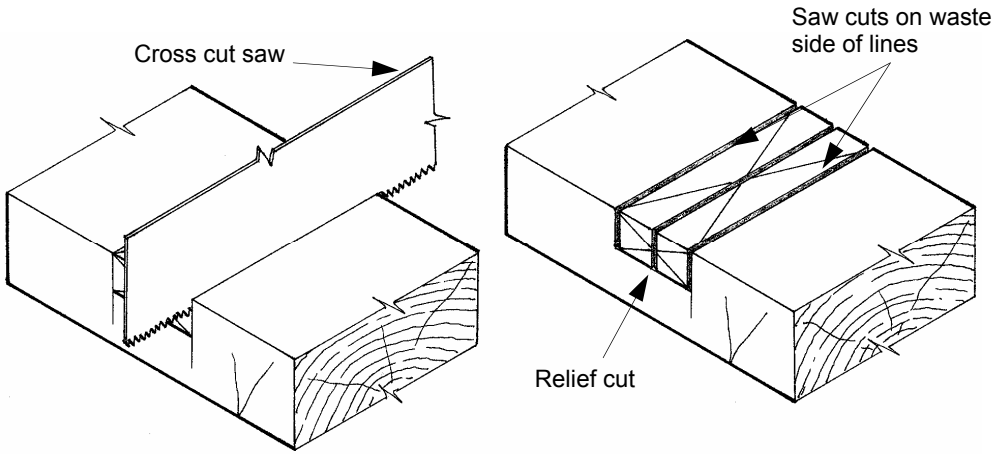


Fig. 51 Cutting on the waste side of the line

STEP 4. Remove the waste with a sharp wide chisel. Firstly, tap the chisel lightly along the depth marks on both edges. This will prevent any splitting out below the depth marks when chiselling out the waste. Secondly, chisel out small sections of waste working from both edges. This will prevent large chunks being torn out which create hollows in the housing.Thirdly, pare the base of the housing to form a smooth, flat surface. Alternatively, a hand router may be used to provide a flat straight surface, especially for joinery work.

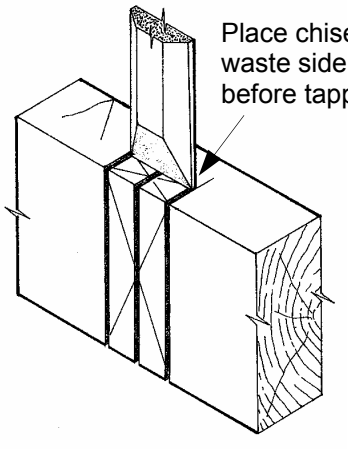


Fig. 52 Tap the chisel along the depth marks

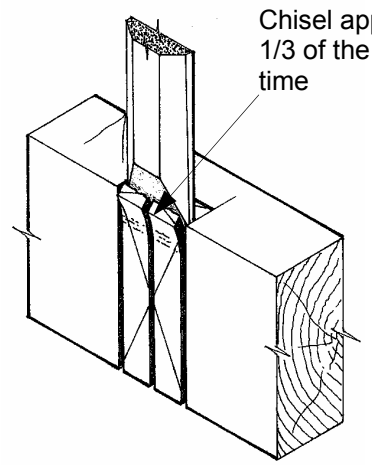


Fig 53 Chisel out small sections of waste

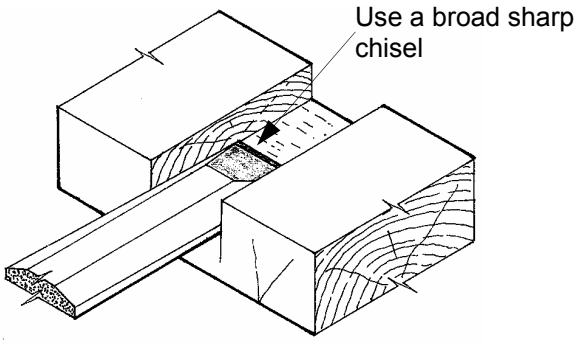


Fig. 54 Pare the bottom of the housing smooth and straight

VARIOUS TYPES OF HOUSINGS

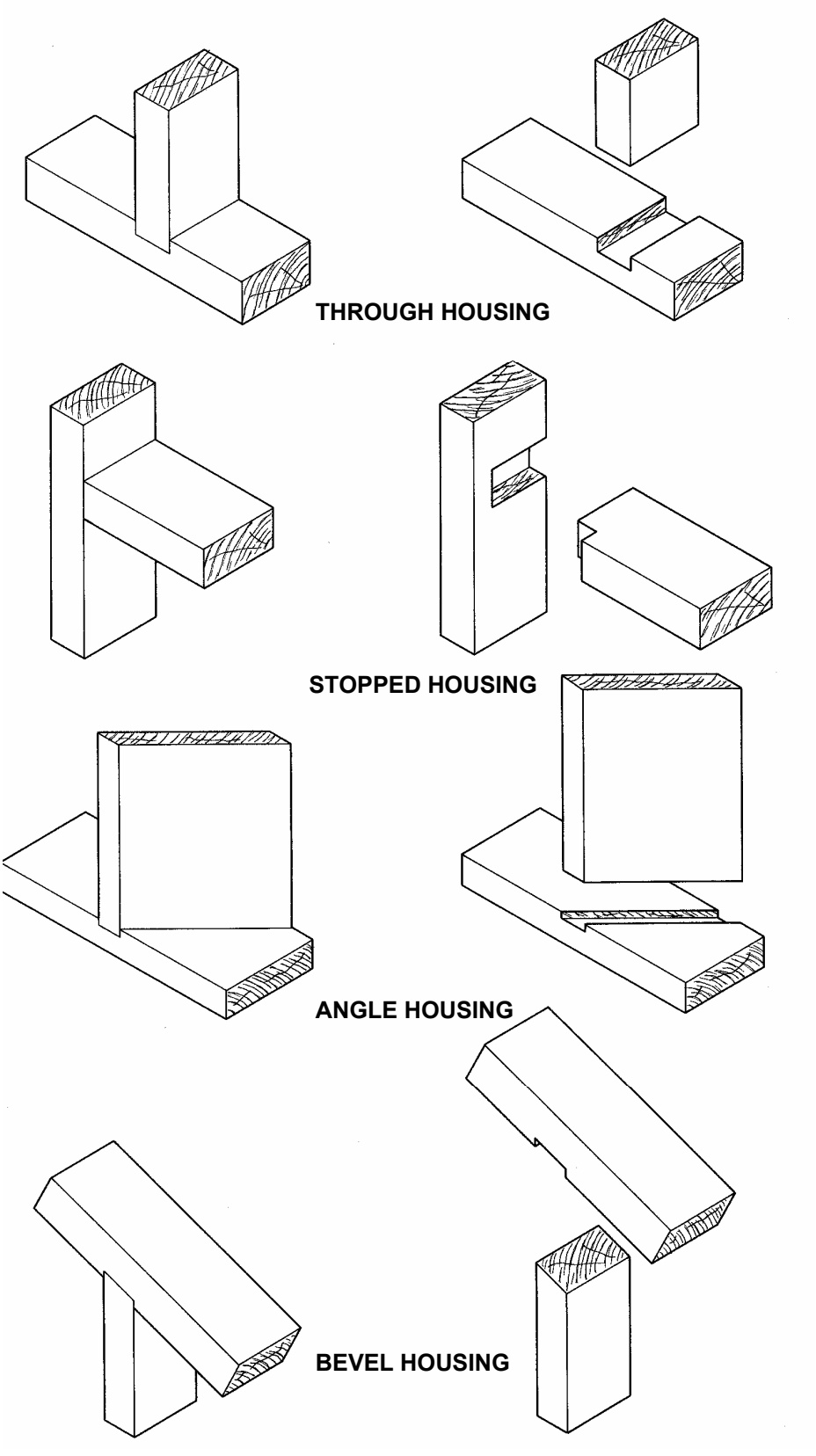


Fig. 55 Housing joints

Mortise and Tenon Joints

This is the most common type of framing joint used for joinery doors, panelled doors, timber window sashes, etc. The joint consists of a thin section on one end of a piece of timber called the 'tenon' and a slot in another piece of timber, which is the same thickness as the tenon, called the 'mortise'. When the two are glued and fitted together the joint has two wedges driven into either side of the tenon to provide a locking action. The joint may also be pinned through the face instead of fitting wedges.

Common or Through Mortise and Tenon

This joint is normally used where a rail meets a stile and there is at least a small section of stile on either side of the joint. The rail will have a tenon cut on the end, which is equal to the full width of the rail, and a thickness equal to one third of the rail thickness, or the nearest chisel size. The stile will have a mortise which is complimentary in size to the tenon on the rail. The outside edge of the mortise will have a wedge allowance cut on either side to allow the tenon to be locked in when the joint is assembled.

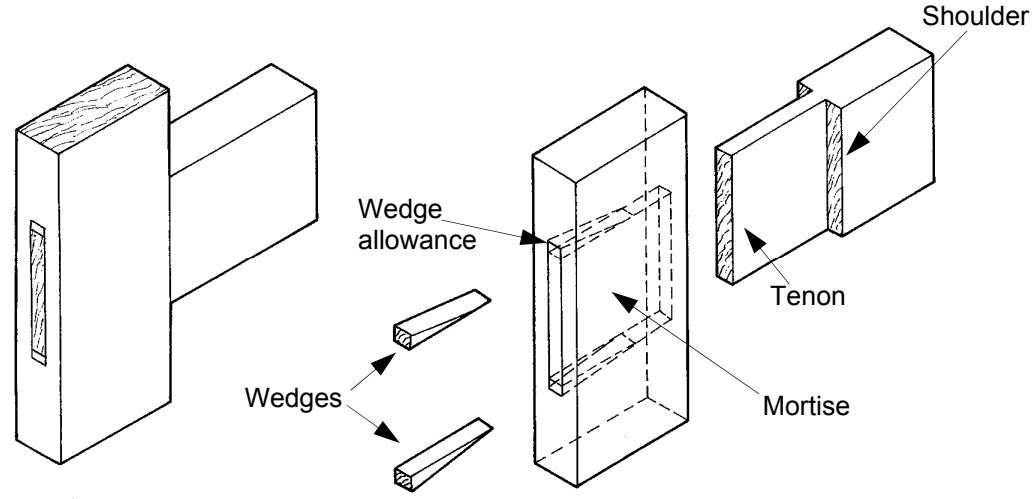


Fig. 56 Common mortise and tenon joint

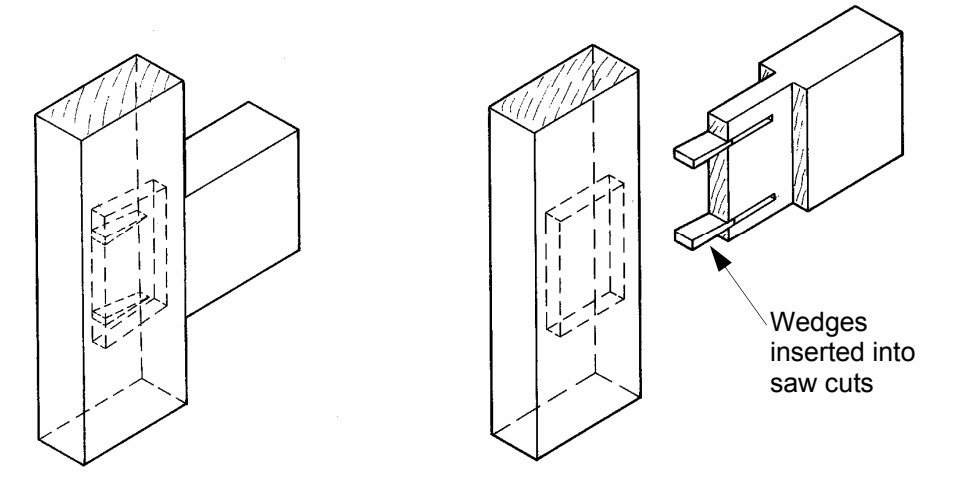


Fig. 57 Pinned or Foxwedged stub mortise and tenon joints

Single Haunched mortise and Tenon

This joint is used at the end of a stile where there is no timber on one side of the joint. The haunch or cut away tenon remains concealed. If the tenon is exposed at the end then the joint becomes known as a 'bridle' joint.

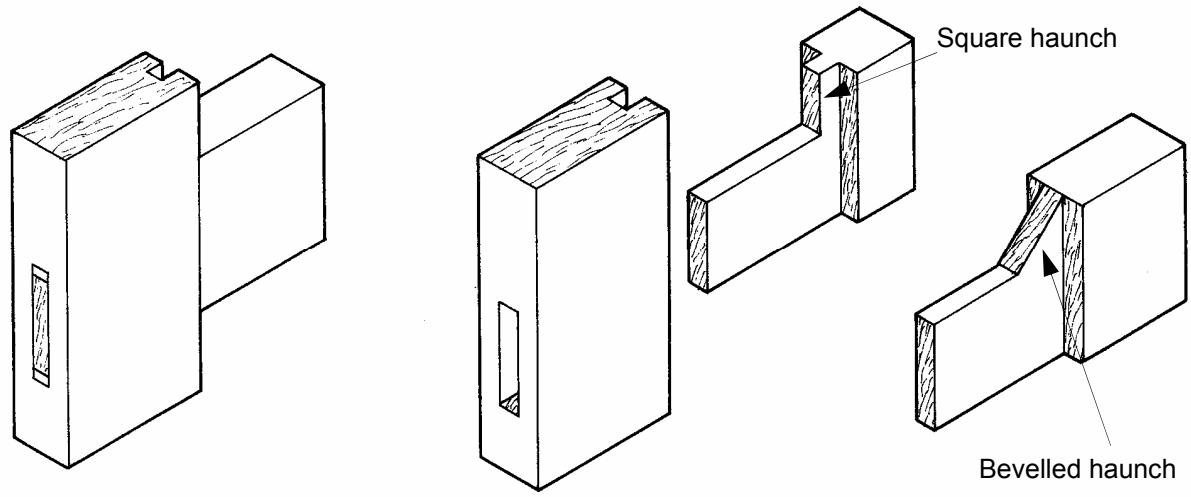


Fig. 58 Haunched mortise and tenon

Barefaced Mortise and Tenon

This joint is used where the rail is thinner than the stile and the mortise is required to be kept close to centre. The tenon only has one shoulder and is kept flush with one edge.

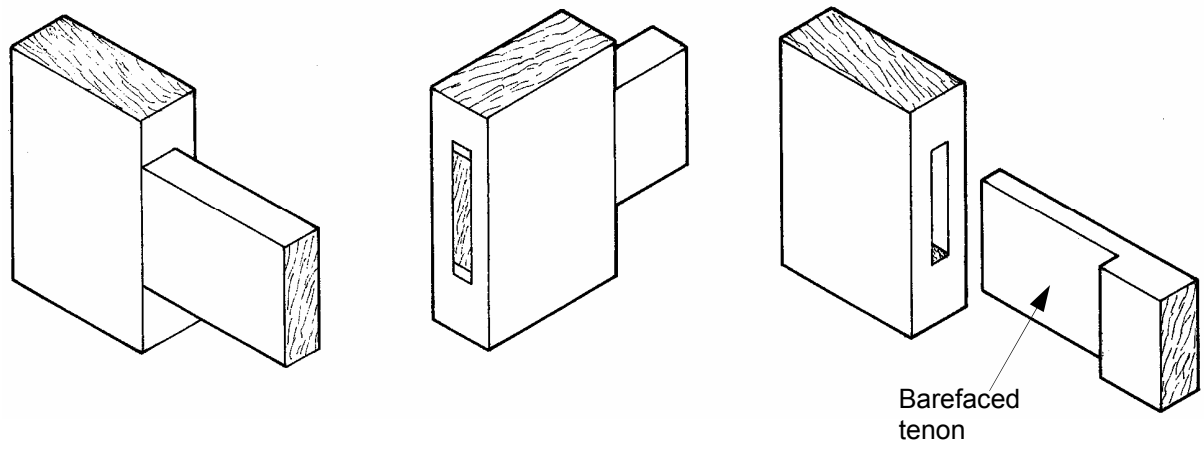


Fig. 59 Barefaced mortise and tenon

Double Haunched Mortise and Tenon

This consists of two haunched tenons cut on the end of a wide rail, which is to be fitted to a stile. The double tenon prevents the wide rail from twisting at the joint. These joints are commonly used for the bottom rail to stile connection on a framed door.

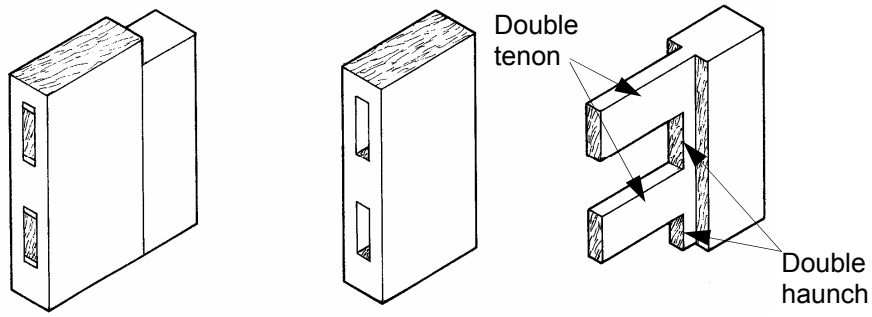


Fig. 60 Double haunched mortise and tenon

SET OUT AND CONSTRUCTION OF THE JOINTS

A similar process is involved in setting out all mortise and tenon joints. The following steps may be applied to any of the above joints with only a slight variation for each individual joint:

Construction of a Common Mortise and Tenon

STEP 1. Select and mark the face side and edge on each piece.
Mark the position and width of the mortise on one edge of the stile, using the end of the rail as the template, and square these marks around to the opposite edge.
Add a wedge allowance on the outside of the stile, which should be equal to a slope of 1:12. Set out the length of the tenon to be equal to the width of the stile plus approx. 2mm waste.

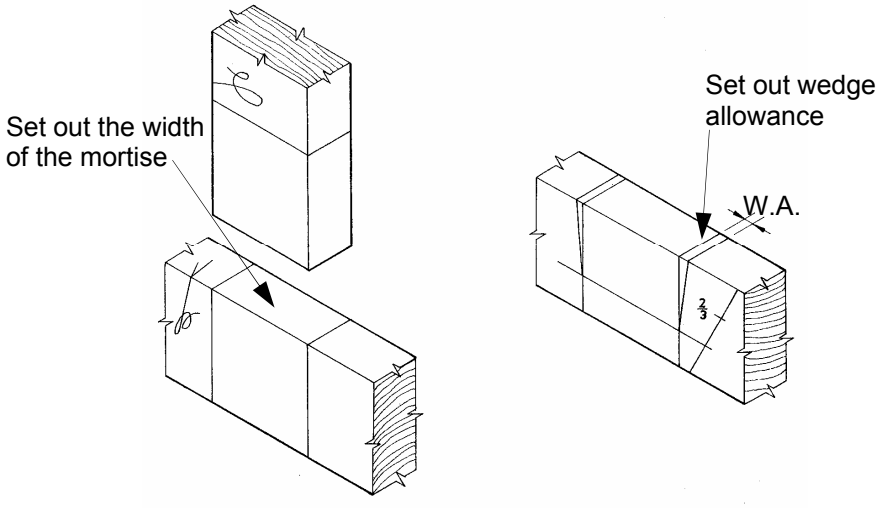


Fig. 61 Setting out the stile including wedge allowance

STEP 2. Select a chisel which will be used to cut the mortise. It should be equal to or close to one third of the stile thickness.
Set the two marking spurs of the mortise gauge to suit the width of the selected chisel and set the stock to suit the distance from the face side of the stile to the first edge of the mortise.
Gauge double lines on both edges of the stile ready to be chiselled out.
At the same time, use the same gauge set up to gauge the tenon on the end of the rail, also from the face side. Mark the two sides and the end of the rail.

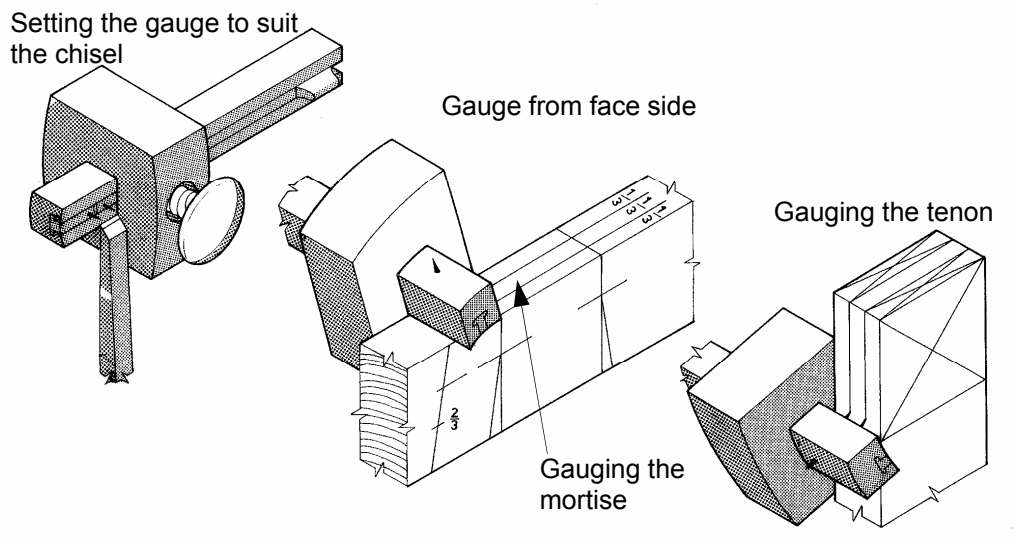


Fig. 62 Gauge the edges of the stile

STEP 3. Clamp the stile to a chiselling block and start chiselling small chunks out of the mortise on one side, starting at the centre and working towards one end.
Chisel part of the way through from one side, then turn the stile over and repeat the operation from the other side until the chisel breaks through.
Chisel out the waste on either end of the mortise to form the wedge allowance, on one edge of the stile only.

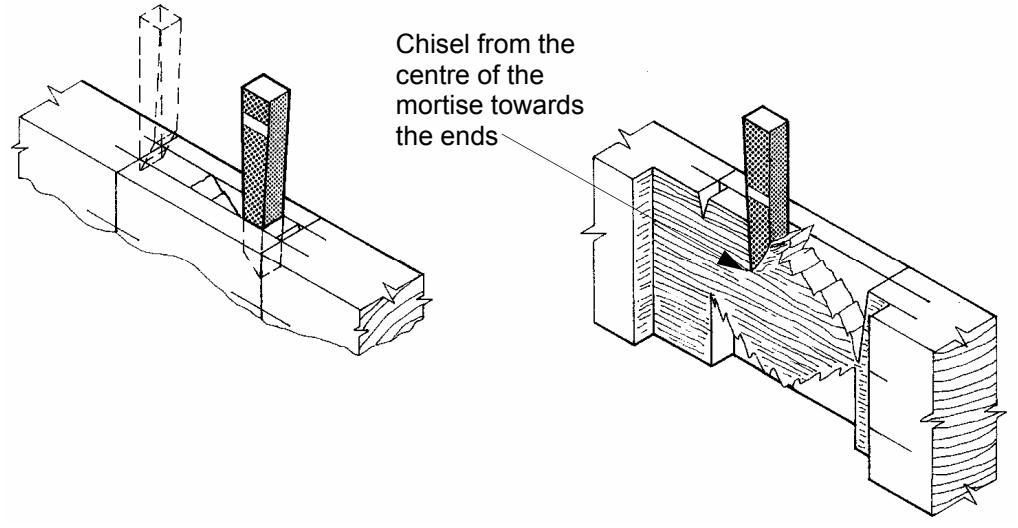
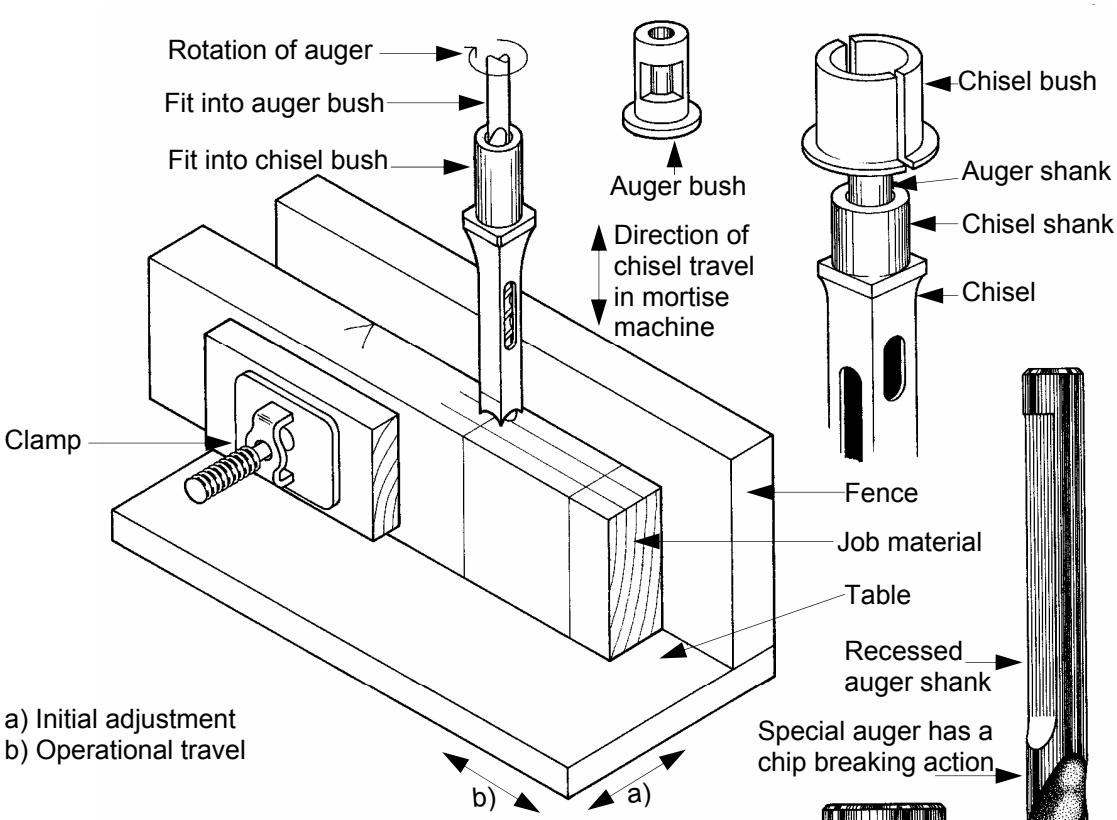


Fig. 63 Chisel out the waste and create wedge allowance

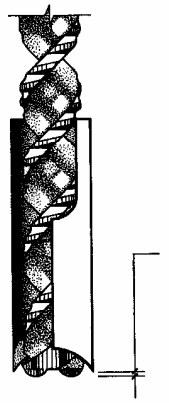
ALTERNATIVE METHOD OF REMOVING WASTE FROM THE MORTISE



BASIC MACHINE MORTICING

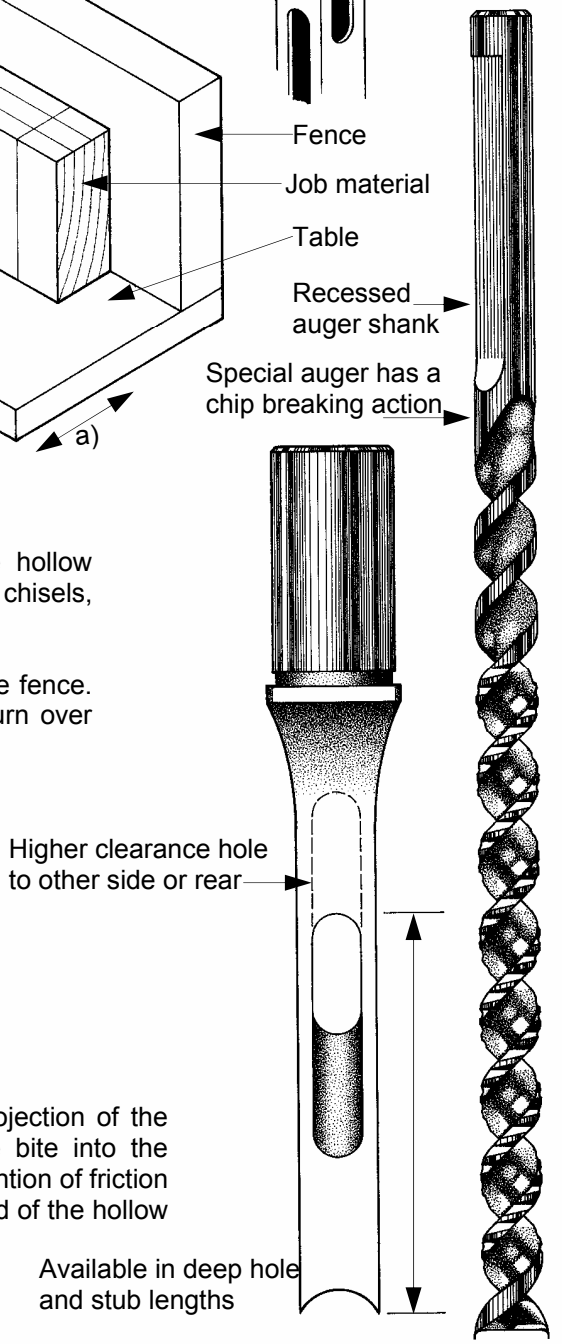
NOTES: Select a drilling speed to suit the hollow mortise chisel size. Higher speeds for small chisels, lower speeds for large chisels.

Place the face side of the material against the fence. Mortice half way through the material then turn over and mortice out the remaining waste material



Allow a slight projection of the auger to provide bite into the timber and prevention of friction burning to the end of the hollow bit.

ADJUSTMENT OF AUGER



HOLLOW MORTISE CHISEL AND AUGER

Fig. 64 Machine mortising

STEP 4. Place the rail in the vice on an angle so the marks for the tenon are visible on the edge and the end.
Use a tenon saw to rip along the marks which form the cheeks on the edge and end.
Turn the rail over and repeat the process.
Turn the rail to a vertical position in the vice and cut square across on both sides of the tenon down to the shoulder lines.

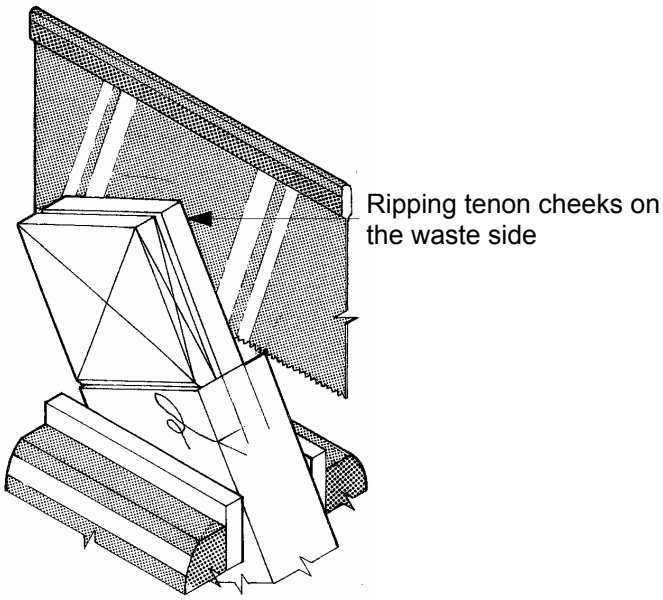


Fig. 65 Rip the cheeks of the tenon

STEP 5. Place the rail on a bench hook and cut across the shoulder line down to the tenon.
Turn the rail over and repeat the process for the other side.
Pare the tenon with a wide sharp chisel to remove any remaining waste.

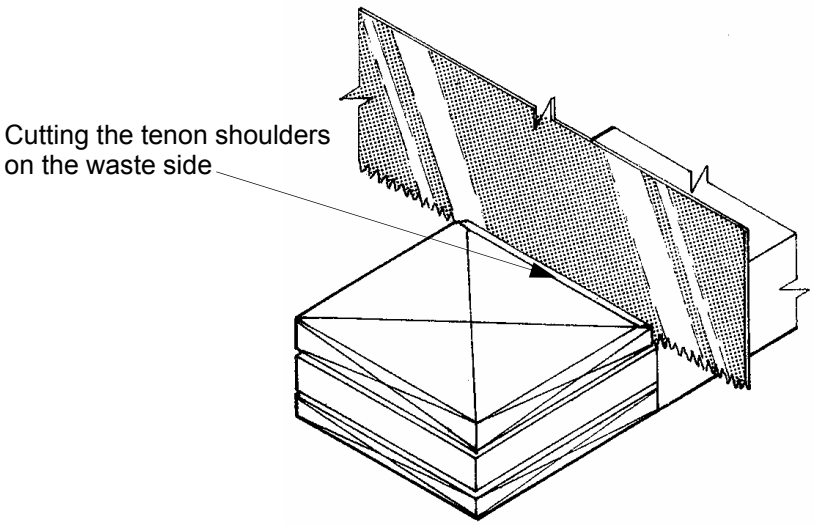


Fig. 66 Cut the shoulders of the tenon and clean up

STEP 6. Fit the joint together, dry, and prepare the wedges. The joint should be a hand tight fit which may be pulled apart without excessive force.
Apply adhesive, such as PVA, to the joint surfaces and press together.
Cramp the joint tightly, square up if a frame is formed, apply some adhesive and drive in the wedges.

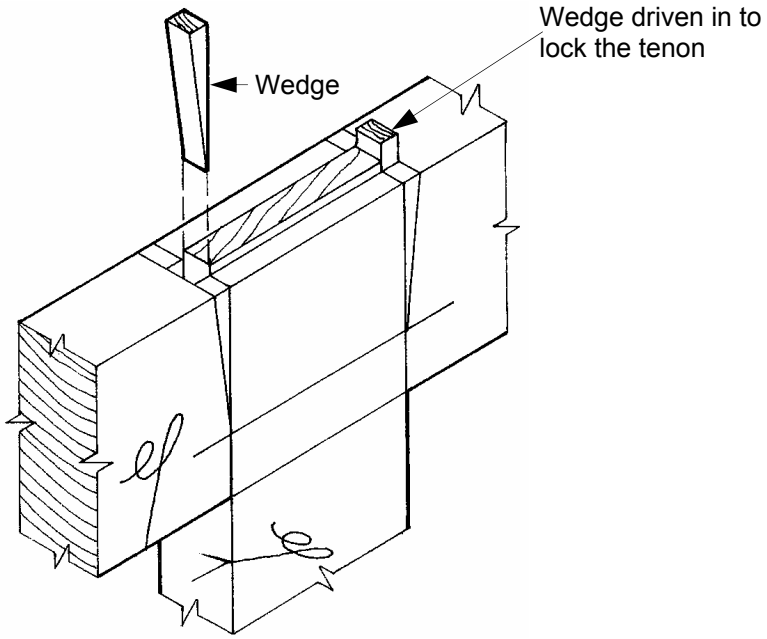
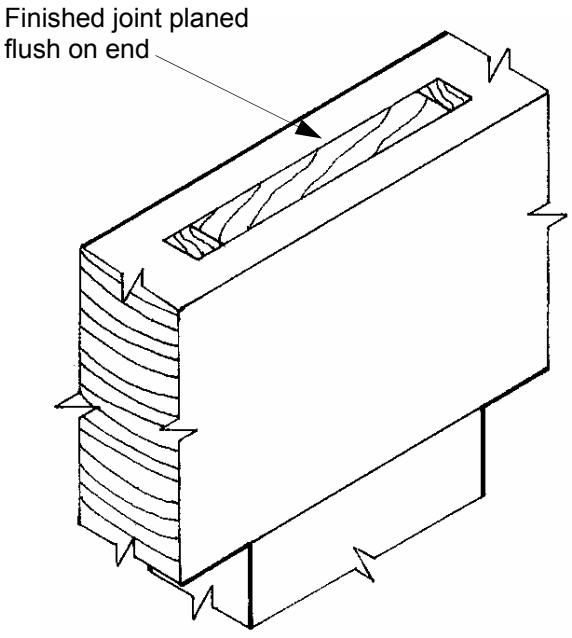


Fig. 67 Fit, glue, cramp and wedge the joint

STEP 7. When the adhesive has set, remove the job from the cramps, place it in the vice and plane the protruding tenon and wedge ends flush.



FINISHED JOINT

Fig 68 Dress the joint

Dowelled Joints

Dowelled joints used in joinery give good results. They are prepared by boring holes in adjacent pieces of timber to be joined. The pieces are then connected by the dowels, cylindrical wooden pins, which are glued into the corresponding holes.
As less labour is required in making dowelled joints they are cheaper to prepare. Less timber is needed, as no provision for a tenon is required, therefore a considerable saving is made when the stiles and rails are of large section sizes.

Setting out

The strength of framing joints depends mainly on their rigidity, which is ensured by maintaining pressure at the shoulders. The number and spacing of the dowels is therefore critical.
The number of dowels required will depend on the width of the timber. One dowel would allow the rail to pivot or cup, therefore a minimum of two are required. If the dowels are too far apart the rail may still cup and if too close together it could lead to splitting of the rail.
As a good practical rule:

- allow one dowel for every 40mm of rail end width and not closer than 12mm to an edge.
- allow one dowel for every 150mm of length when joining timber at the long edge.

The diameter of the dowels should be as near as possible to one third the thickness of the rail but not more than half the rail.

Jigs

When setting out several jobs, templates can be used to advantage. These may consist of timber or metal with small holes corresponding to the positions of the dowels. The dowel positions are marked by pricking through with a nail or scriber. The use of a template ensures accuracy in setting out and matching the holes for the dowels.
There are situations when conventional methods for setting out are not practical or easy. In this situation a ‘spec’ may be used, which is the trade name given to a small metal plug with a point at the axis of one end. The diameter of the plug should be a snug fit in the dowel hole with the shoulder of the spec preventing it from disappearing down the hole.
In cases where specs are used, holes are bored in one member, the specs are placed into the holes, the member to be joined is placed beside the bored member and tapped against the specs. This marks the centre of the holes to match those already bored.

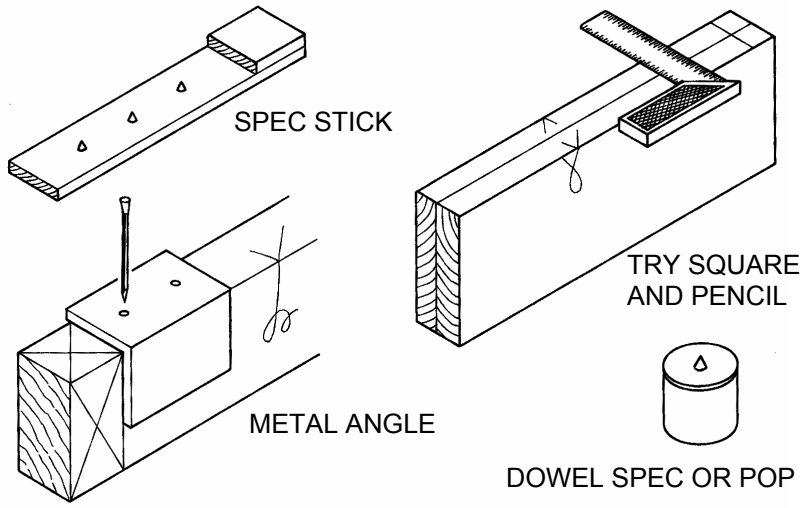
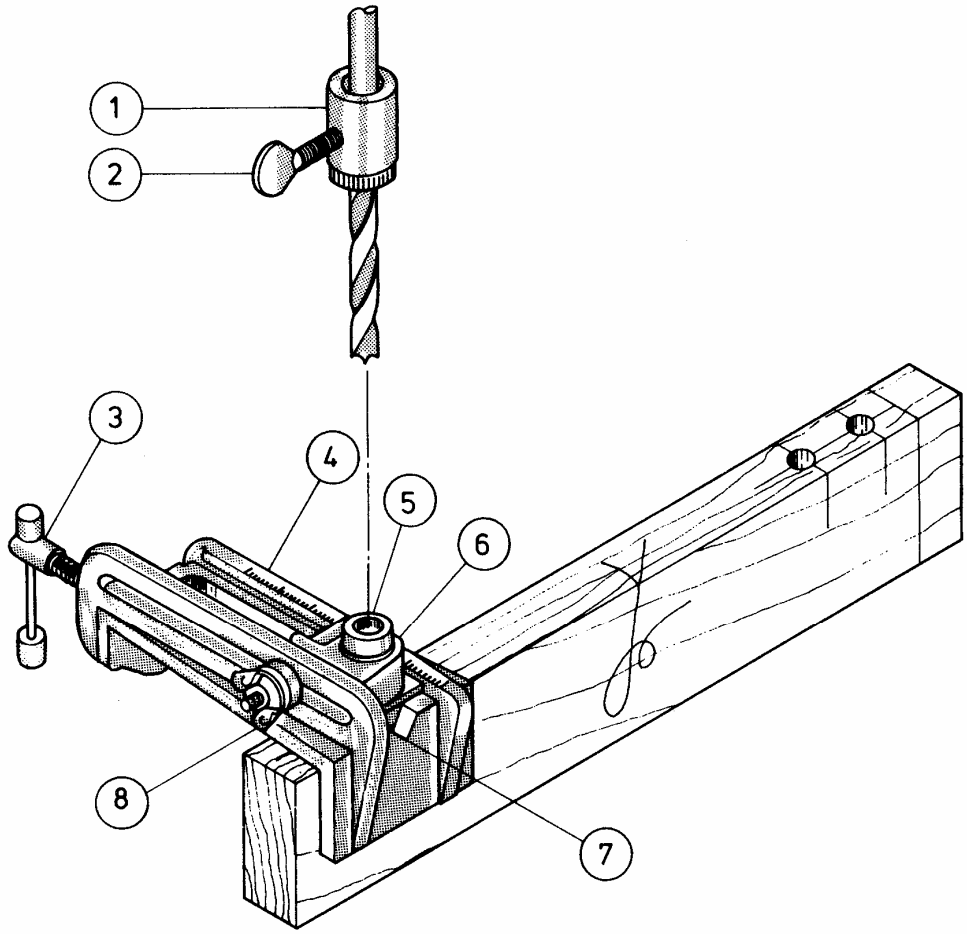


Fig. 69 Jigs for marking centres

Boring Holes

Holes may be bored using a clamp jig and a portable electric or battery drill. The detail below outlines the use of the jig and identifies the parts.

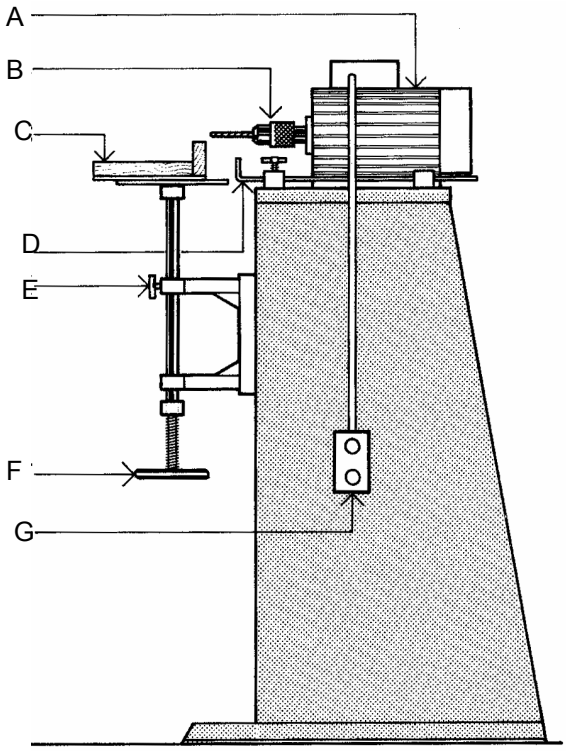


Use of dowelling jig. An electrical drill or a brace and bit are used with a depth gauge for drilling dowel holes.

Item	Part or Function
1	Depth stop
2	Thumb screw or set screw
3	Clamp screw (approx. 75mm capacity)
4	Centering gauge marks
5	Interchangeable guide collars (six sizes supplied)
6	Sliding cradle for guide collars
7	Centering notch
8	Wing nut for adjustment of sliding cradle

Fig. 70 Dowelling jig

Holes may also be bored using a horizontal boring machine or a vertical drill press. Consistent size, depth and position is maintained by using these machines.



Item	Part or Function
A	Motor
B	Chuck
C	Sliding table
D	Depth stop
E	Locking screw
F	Height adjustment
G	Switch

Fig. 71 Typical horizontal boring machine

Drill Bits

A standard twist bit may be used with the clamping jig , but a dowelling centre bit is preferred when using horizontal borers or drill presses to ensure the bit does not wander from the hole centre, when the hole is started.
Countersink bits are used to 'flare' the top of the holes for the dowels so the excess glue has somewhere to go when the joint is pressed together, as hydraulic pressure may prevent the joint being pressed tightly together.

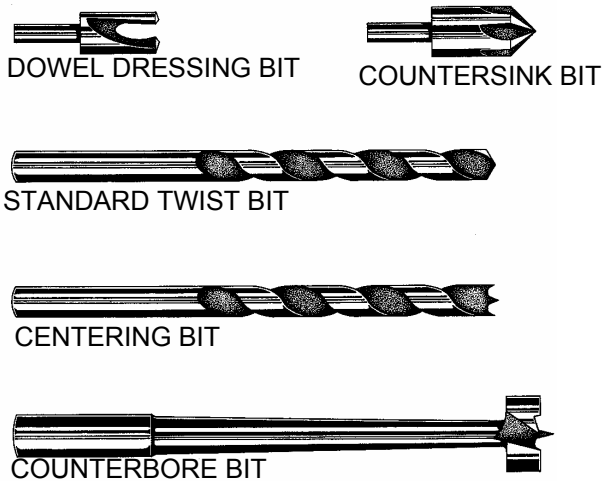


Fig. 72 Commonly used bits for dowelling

Gluing

Bored holes for the dowels only provide minimum clearance therefore the film of glue placed on the surfaces to be bonded is not applied the same as for other closed face joints. When the glue is placed in the holes and the dowels are driven in pressure from the trapped air will prevent complete insertion or it will burst the timber.

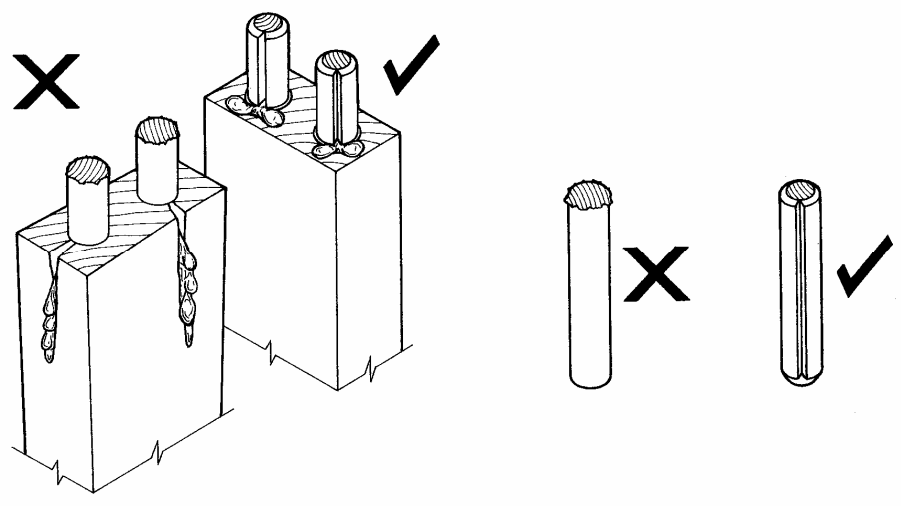


Fig. 73 Result of incorrect and correct preparation

To prevent this occurring, the dowels may have a slot cut along one or more edges, have one side planed flat or be multi-grooved:

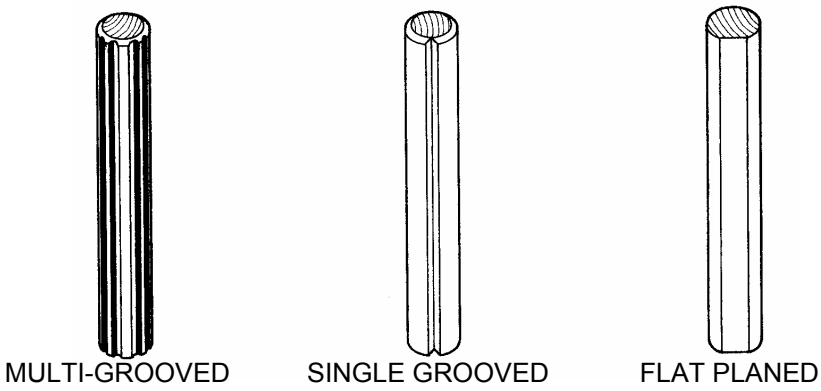


Fig. 74 Prepared dowels

Clearance

Dowel holes are drilled to a depth so that the combined length of the two holes is 2 to 3mm greater than the length of the dowel. It will also be noted that the dowel is chamfered at both ends to help guide them into their holes.

Length

In narrow members, the dowel should e one and one third times the width of the stile, e.g. if the stile is 60mm finished size then the dowel should be 80mm long. This means 40mm into each side of the joint.

TIMBER SURFACE PREPARATION

Abrasive Papers

An abrasive paper is one which has a surface coated with abrasive bonded to a flexible backing for the purpose of abrading materials, to remove marks and prepare the surface for finishing.

Manufacture

Grits for use as an abrasive are graded in various particle sizes, after the stone or manufactured material has been crushed. Grits in use for general work range from *size 12*, very coarse, to *size 320*, very fine. Some grits used for other industrial purposes may be as fine as *size 600*.

The grading figure indicates the number of particles, if placed in a line, to cover a lineal measurement of 25mm. The abrasive is stuck to the backing by means of a suitable adhesive. High quality animal glues and synthetic resins are used for this purpose. Abrasive papers may be *open coated* or *close coated*. Open coated paper has 30% to 50% of its area without grit, while closed coated paper has the abrasive grain covering the entire paper surface.

Open coated papers have the advantage of higher flexibility and are less likely to clog during use.

Definitions

Glue bond - a glue bonded product employs an animal hide glue bonding system where both maker and size coat consist of a high quality animal glue.

Durabond - a 'NORTON' development to improve the bonding characteristics of glues and resins used in the manufacture of coated abrasives.

Resinized - such a product has a resin size coat with a glue maker coat.

Resinall - such products use an all resin bonding system, ie. a resin size coat and a maker resin coat.

Openkote - Openkoted products have lower grain densities allowing space between the grains to prevent the coated abrasive loading or filling.

Closekote - a denser coating than Openkote giving more cutting points per unit area. Closekote products generally are not suited for materials where loading occurs, however use of an abrasive restorer can reduce this failure.

Electro-Coating - coating the grain on to the backing to produce a sharper, more uniform coating.

Glazing - this describes the failure of coated abrasives where the grain points become worn and no refracture occurs, ie. no break up of light occurs. The surface may appear to be all shiny and fused together.

Loading or filling - coated abrasives used in the woodworking trade usually fail by loading. The material being sanded fill up the apertures between the grains and naturally clogs the material. Under certain conditions this material may be restored using an abrasive restorer.

Flexing - coated abrasive material just manufactured lacks flexibility because of the unbroken film of glue or resin. It is necessary to break this up by a flexing operation. There are three degrees of flexing normally used, ie single, bi, and tri- flex. Generally the less flexing necessary the better the performance with the product.

TYPES OF ABRASIVE GRAIN

Abrasive grains or grits used for coating papers may be of natural stone or are manufactured in an electric furnace at temperatures of 850°C.

Natural Abrasives

- Flint - a cream to grey colour;
- Emery - black in colour; and
- garnet - red in colour.

Manufactured Abrasives

- Aluminium Oxide - reddish in colour. Trade names are 'ADOLOX' and 'METALITE';
- Silicon Carbide - blue/black in colour. Trade names are 'DURITE', RESINIZED', 'SPEED GRIT', and 'TUFBACK'.

Comparative Grain sizes

Examples are given below of the markings which are placed on the back of the paper to describe the grade of fineness of the grit. Comparable grades are given for various types of paper:

Table 8

SILICON CARBIDE	ALUMINIUM OXIDE	GARNET	ENGLISH GLASS	ENGLISH EMERY	AUSTRALIAN FLINT
240	240	7/ 0 - 240	F Flour	2/0	---------
120	120	3/ 0 - 120	1	F	Fine
80	80	1/ 0 -80	F.2	1½	Medium
50	50	1 - 50	S.2	2½	Coarse

Selection of Abrasive papers

In selecting paper for either hand or machine use, consideration should be given to the following factors;

- Type and size of abrasive grain;
- Whether closed or open coated;
- Type of backing; and
- Type of adhesive

Aluminium Oxide papers are the best available for general use.

Garnet has the best cutting property of the natural stones, is suitable for hard work and many classes of machine work.

Silicon Carbide papers are particularly good for floor sanding, where the paper is subjected to hard use.

Paper backings vary in strength, with the better quality papers possessing a high degree of flexibility and toughness. If very high strength is required a cloth backing should be used. Abrasives stuck with animal glue are suitable for most work if used dry. Where wet sanding is necessary, papers made with synthetic resin adhesive is recommended.

Use of Abrasive papers

- A common size of abrasive paper sheet is 275 x 225mm. This will cut into six pieces for use with a cork or rubber sanding block;
- When preparing timber surfaces by hand, care should be taken to work only along the direction of the grain using a uniform pressure throughout;
- The grade of the paper will vary according to the timber and the fineness of finish required;
- 60 or 80 grade papers would generally be suitable to remove marks left by machines or hand tools and finishing work may be carried out using 100 to 180 grades;
- Greater grades than 180 are suitable for very fine finishes or to cut back between coats of shellac or varnish. The higher grades are also used on soft materials such as plaster set where small amounts are to be removed without scoring the set or tearing the outer paper surface of plasterboard type materials;
- papers for machine use are available in sheet, roll and belt form. They may be used on belt sanders, drum type machines, discs and orbital sanders, either fixed or portable types; and
- Use a face mask or respirator when sanding, especially in confined and poorly ventilated areas. The fine dust produced during sanding may irritate the nasal passages, throat and lungs. Some people are allergic to timber dust, such as Western red cedar, and have an adverse reaction to it, which may require medical treatment.

FINISHES

Primers

If timber is exposed to the weather without any protection, especially joints, water will be absorbed causing swelling and timber decay or cracking when it dries out. Therefore the joints of weatherboards, door and window frames, pergolas, etc require some priming or preservative treatment. The priming coat is the first coat applied to the raw timber in the painting operation. If the surfaces are to be stained, linseed oil is an ideal base to use as it soaks into the timber without changing the colour of the timber dramatically.

Note: Lead based paints are no longer used due to their toxicity.
The most common types of primer are 'pink' and 'white' which come in mineral and water based form. Most preservative treatments include a *fungicide* and may include a *herbicide* as well. These are usually applied prior to the primer if they are to be used and they prevent fungal growth occurring on the raw timber.

Purpose of primers

The purpose of the primer is to seal and protect the timber and also form the basic paint film for covering coats to adhere to, known as the undercoat and finishing coats.

Preparation

The surfaces to be primed should be clean and sanded smooth with the sharp edges removed with an abrasive paper. All nails should be punched below the surface, up to 3mm and filled with putty or a timber filler. Knots and gum veins should be sealed with varnish or similar to prevent excessive paint absorption or bleeding from the veins at a later stage.

Application

Primers should be carefully applied, preferrably using a brush, paying particular attention to the corners, nail holes, joints and end grain. It is most important that the priming is done thoroughly as subsequent coats rely heavily on the effectiveness of the base coat. It is preferable that joinery items are primed prior to leaving the workshop and *fascias, barges* and *weatherboards* are primed prior to fixing.

Shellac

This is a natural resin-like substance, more correctly it is a gum as it is soluble in alcohol or white spirit, produced as an exudate by a small Lac beetle, Latin name - *Tacchardia Iacca*, which feeds on the sap of a specific species of fig tree in India and China. The residue, which adheres to the branches, is either scraped off or melted off and is then turned into thin orange coloured flakes known as hypochlorite, a type of bleach and may be used on light coloured timbers. The finished colour on timber, of Orange Shellac, is a honey/brown colour.
To produce shellac in a useable liquid state, it must be *slaked* down using white spirit or methylated spirits, which may take up to 24 hrs to completely dissolve.
Shellac can be used as a sealer and dries very quickly, due to the evaporation of the methylated spirits, therefore when it is applied with a brush it should be *laid off* as quickly as possible to prevent streaking. Several coats may be required to achieve a rich finish by leaving each coat to dry for several hours, lightly sanding and then applying the next coat.

Shellac is also the basic material used for 'French Polishing' where the shallac is applied thinly using a cloth and rubbed into the timber grain until a burnished effect is achieved. This process is mainly carried out by furniture and antique restorers due to the high labour content involved in the process.

Paint

Modern paint had its beginnings around the 1920's, however simpler forms of paint have been around for around 50,000 years. The mixture consists basically of pigment, binder and a solvent. The pigment is mined or manufactured in the form of a fine powder that gives paint its colour and *opacity*, ie it doesn't allow light to pass through.
The binder is the liquid part of the paint, which may be an oil such as linseed or it may be a resin.
The binder holds the pigment together and enables the paint to stick to a surface.
Solvents are used to dissolve the resins or thin the oils to make paint workable. Solvents are an extract of petroleum oils such as *Mineral turpentine*.
Paints for building purposes are available in two forms:

1. **Oil paints** - solvent thinned; and
2. **Latex paints** - water thinned.

Oil paints contain pigments, binders, solvents, driers and extender pigments. They are designed to soak into the surface, lock into it and provide a key for the next coat. The range of oil paints consists of:

- primers
- sealers
- undercoats
- flat finish
- satin finish; and
- gloss finish - Interior/Exterior

Thinning and washing up is carried out using mineral turpentine, commonly referred to as turps.

Latex paints contain pigments, binders, solvents, driers and also extenders. The main differences between oil and latex paints are the limited surface penetration of latex paints and the use of water instead of turps for thinning. Clean up is also carried out using water but it should be noted that for complete cleaning of brushes and rollers it is necessary to use warm soapy water in the final clean up to remove all paint from the bristles.
The range of latex paints available is the same as for oil-based paints, but the latex range also includes acrylic and vinyl paints such as 100% acrylic, vinyl, vinyl/acrylic, and vinyl/ lates paints. The variation in this range is due to differences in the binder.

USE AND APPLICATION OF PAINTS

Generally, oil-based and water-based paints can be used either internally or externally. Oil-based paints are preferred externally for their ability to soak into materials and seal them from the effects of weathering, but in recent times water-based paints have been used externally for their ease of application, cost and clean-up properties. The range of uses, for both types is as follows:

- *Primer* - penetrates and seals the surface and provides adhesion for the next coat;
- *Sealer* - designed to stop suction or absorption at the surface and provides a base for the next coat;
- *Undercoat* - adds film thickness and contains more pigments for grain/tesxture filling and provides good sanding ability for a smooth finish;
- *Flat finish* - not designed for external use as it attracts dust and dirt. Mainly used for general ceiling finishes;
- *Satin finish* - mainly used for internal areas where washing is required, such as bathrooms, laundries and kitchens. It may be used on ceilings or walls; and
- *Gloss finish* - may be used internally or externally where a hard, shiny, durable finish is required for appearance and ease of cleaning. It is generally not used for wall and ceiling finishes as it shows all the unevenness in these surfaces and tends to throw shadows, making it look even worse.

All types of paint can be applied by using a brush, roller, paint pad or sponge, sheep skin or synthetic paint mitten and also by spray gun. The surface, position, cost, end use, texture required and durability will determine the appropriate application method.

Fillers

These are smooth paste mistures used for filling slight surface imperfections. They range from the plaster/cellulose-based (‘Polyfilla’ type) to thinned brush or spray fillers. Fillers are used to form a blemish-free surface ready to receive a paint or stain finish.
Fillers can be applied with a spatula or putty knife, a tube and gun - as with common caulking or joint/gap compounds, by rubbing the grain of timber with a cloth or may be brushed or sprayed on.

Brushes and Rollers

Good brushes and rollers are expensive, therefore the utmost care should be taken to ensure they are kept in good condition. They should be cleaned after every use in the appropriate solvent, recommended by the manufacturer, and be ready for use when next required.
After cleaning they should be stored in a position where they cannot be contaminated by dust, corrosive liquids, powders etc.

Application Hints

- Paint with a fully loaded brush to avoid removal of the previous paint applied;
- Apply primer to the edges, internal surfaces and recesses before the remainder of the job;
- Ensure that surfaces to be primed are free of all grease, dirt and dust before applying the primer. If applying paint inside use drop sheets in case of drips and spillages; and
- It may be wise to place ‘Wet Paint’ signs close to the work where unsuspecting persons might brush up against or sit on the freshly painted work..

STRUCTURAL BUILDING ELEMENTS

The purpose of this section is to provide information and details of typical structural elements, which may be used for reference and sketching exercises. The details cover elements found in residential and some commercial construction such as typical footing types, a variety of ground floor systems using timber and concrete, timber frame construction details, and common roof types for residential and commercial construction.

FOOTING TYPES

Blob Footings

They are used in both domestic and commercial buildings and are generally constructed of mass concrete, placed under piers or columns. Footing sizes range from 400 to 600mm square with a minimum depth of 200mm, according to AS 2870 - 1996.

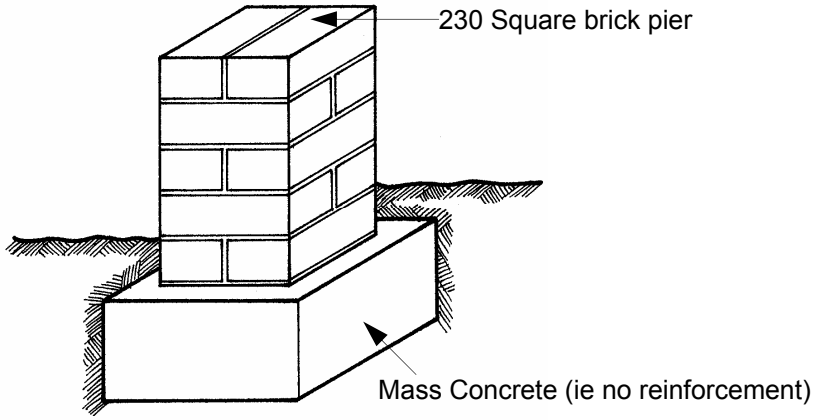


Fig. 75 Blob Footing

Strip footing

This is a square or rectangular sectioned reinforced concrete strip running around the perimeter of the building to support the load. It has a minimum section size of 300 x 300mm, according to 2870 - 1996. Strip footings may also be stepped where a sloping site is encountered.

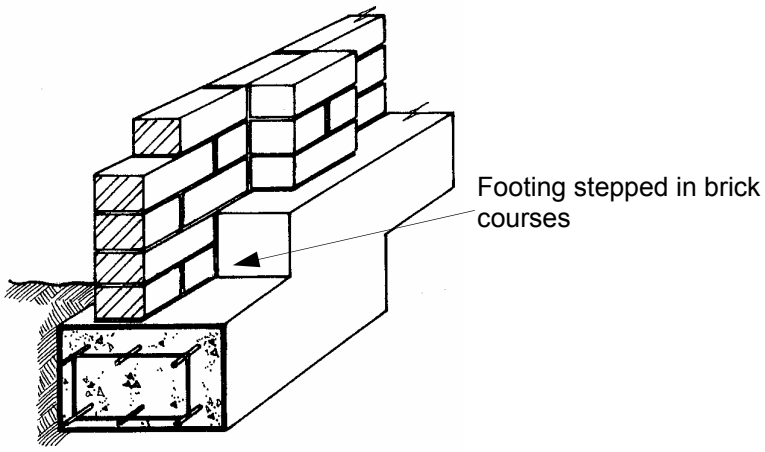


Fig. 76 Stepped strip footing

Deep Beam footing

These footings are similar to the basic strip footing apart from the deep section size of the footings. They are designed to be used where the bearing value is good but the foundation material is reactive, such as found in clay soils. Another version of the strip footing is a combination of basic strip and deep beam, which forms an 'Inverted 'T' Beam' footing used where the foundation material has a poor bearing value and may be reactive.

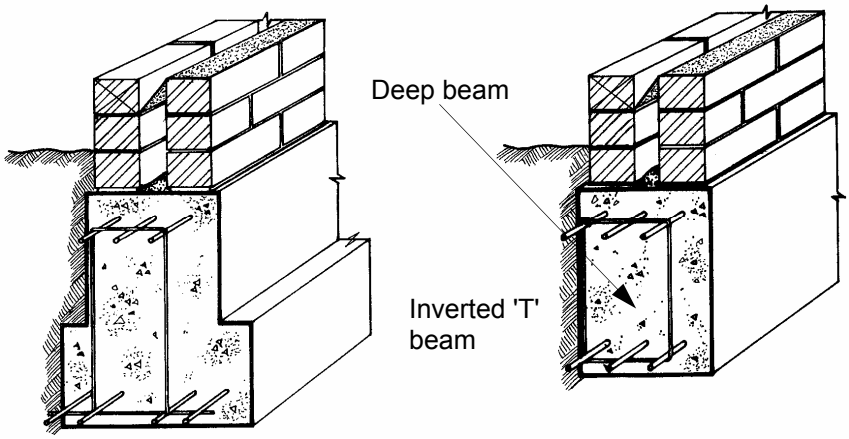


Fig. 77 Alternative strip footing types

Pier and Beam footing

Tends to be used where the foundation material has a poor bearing value or there is fill under part or all of the structure. The beam is usually a minimum of 300 x 300mm square with the piers being a minimum of 300mm diameter, at centres specified by a Structural engineer

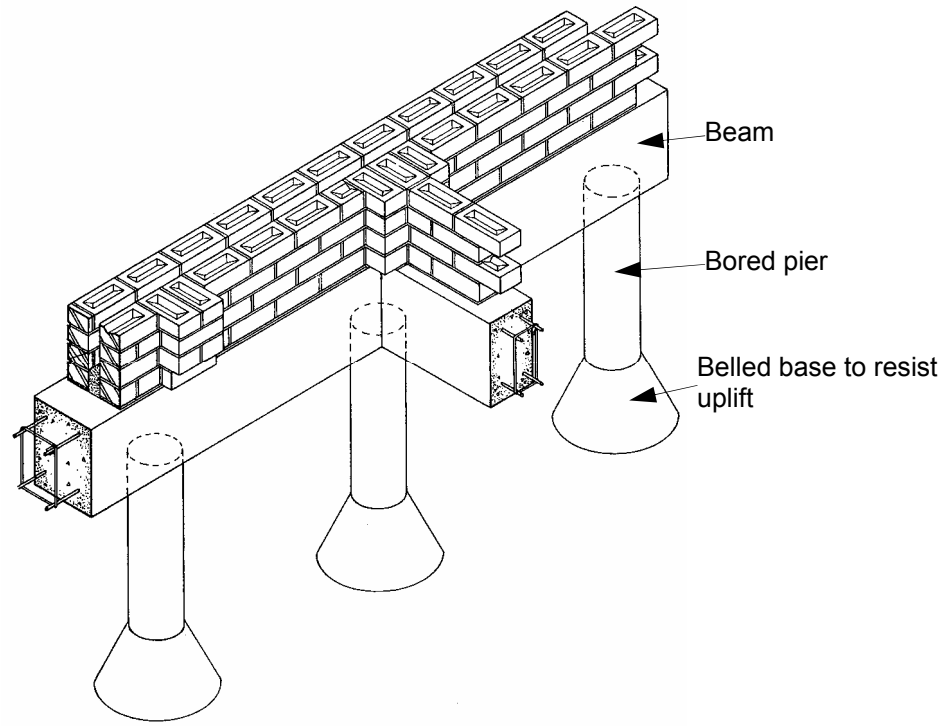


Fig. 78 Pier and beam footing

Slab-on-ground with thickened edge beam

The slab-on-ground is of reinforced concrete, usually with a thickened edge beam to support external wall loads. The width of the thickened area is a minimum of 300mm, as per AS 2870 -1996. The slab may also be thickened where load bearing internal walls occur and would be a minimum of 150mm thick, when the main body of the slab is 100mm thick.

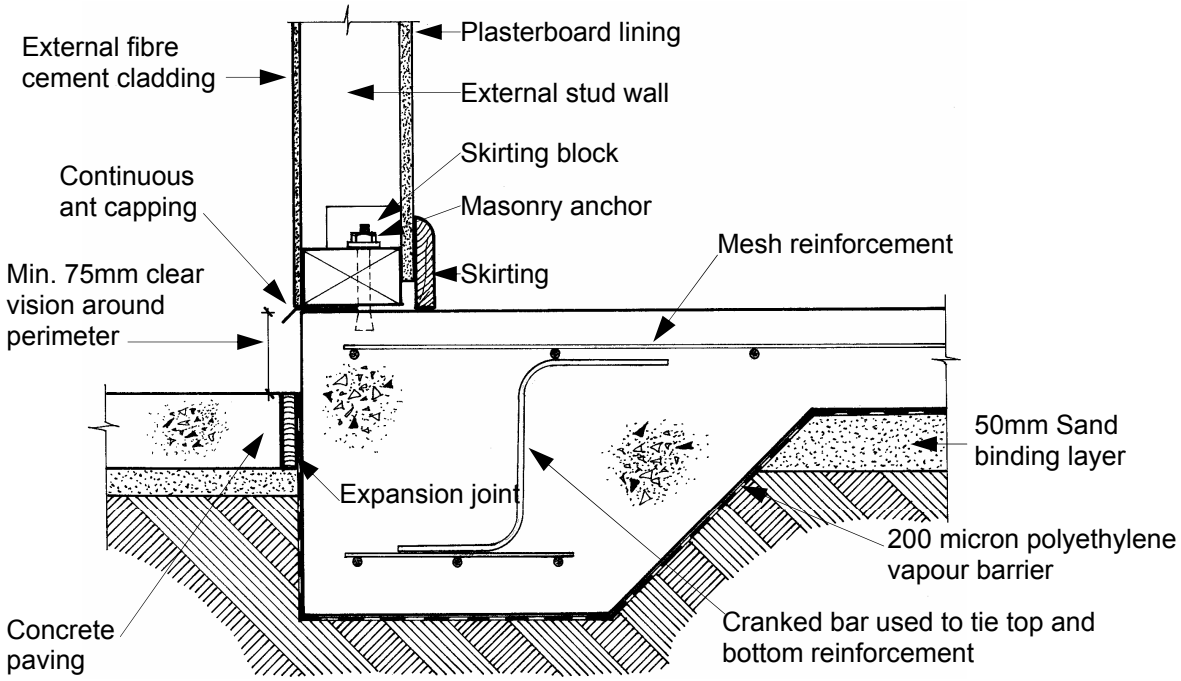


Fig. 79 Slab-on-ground with thickened edge beam (timber frame)

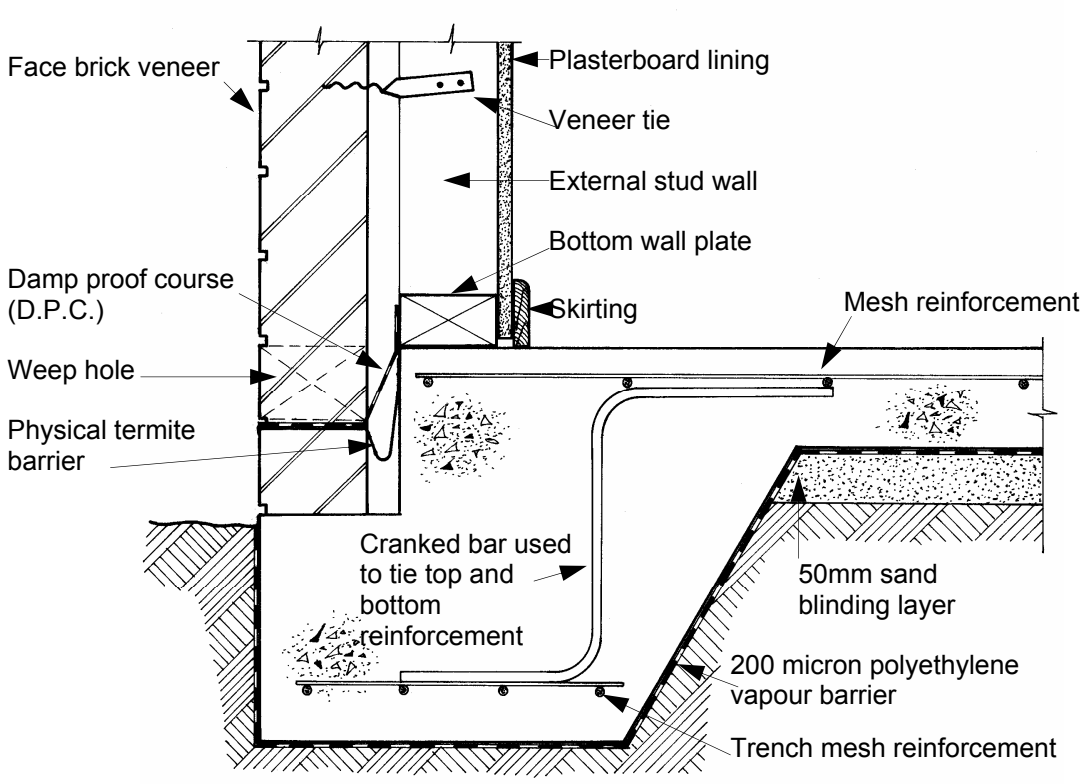


Fig. 80 Recessed and thickened edge slab (brick veneer)

SUSPENDED TIMBER FLOOR AND WALL FRAMES

Conventional timber floor frames commonly consist of hardwood timber bearers and joists with tongue and grooved hardwood or softwood flooring or structural particleboard or ply sheet flooring over. These frames may be supported on isolated piers and/or dwarf walls,around the perimeter for timber wall frame construction, continuous dwarf walls and engaged piers for brick veneer and (cavity wall) construction.

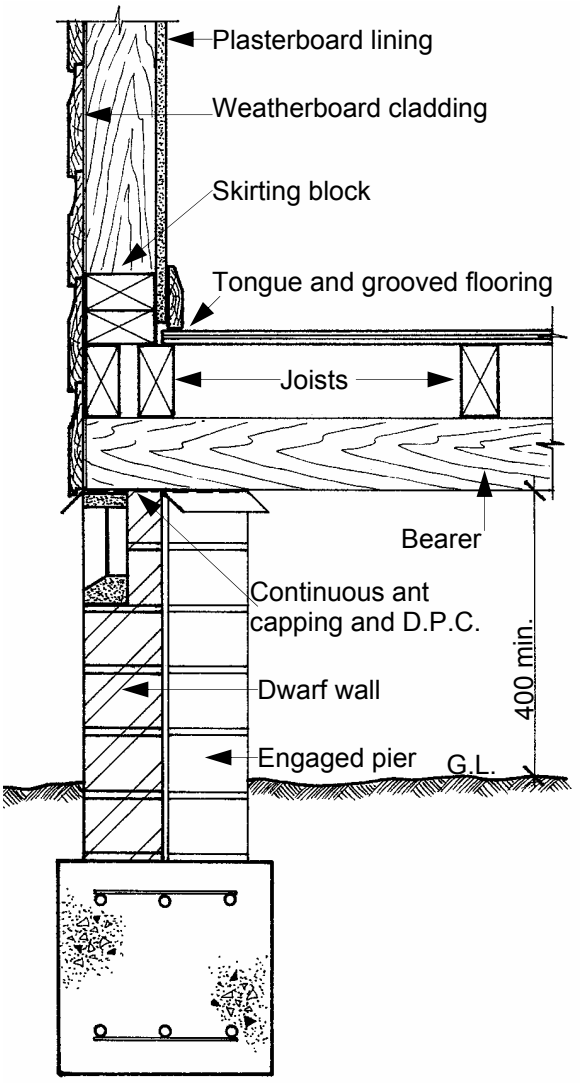


Fig. 81 Ground floor timber frame construction

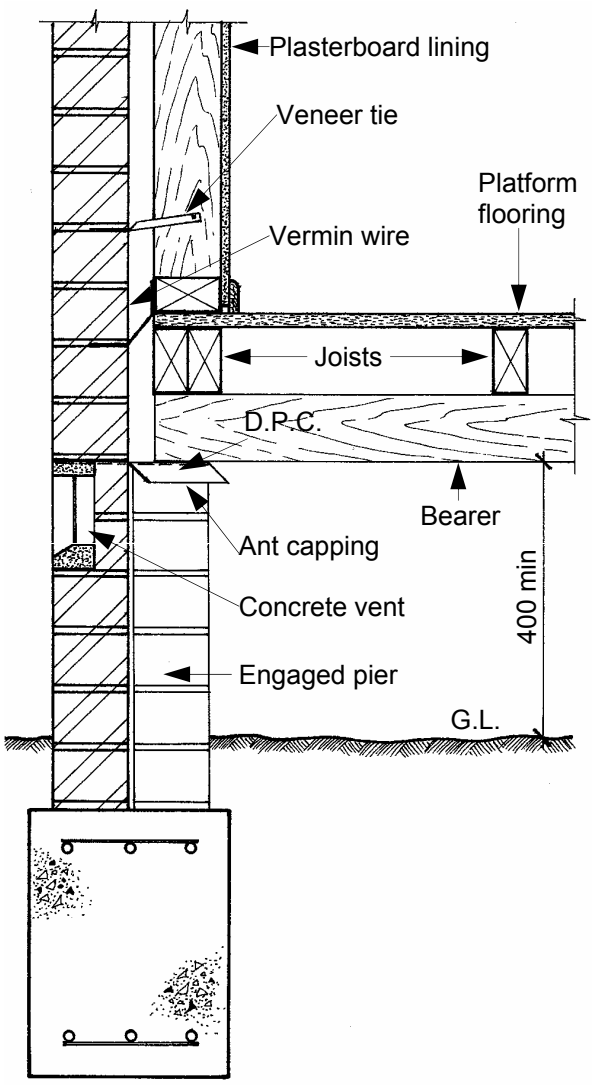


Fig. 82 Ground floor brick veneer construction

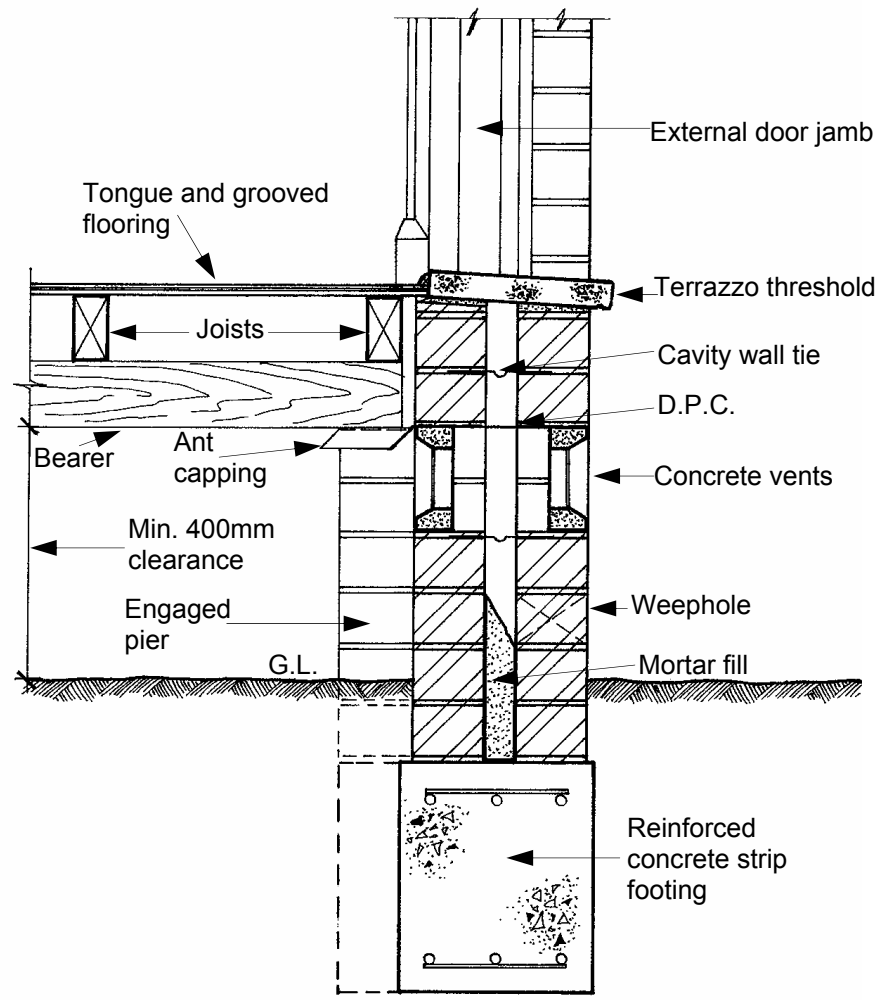


Fig. 83 Ground floor cavity wall construction

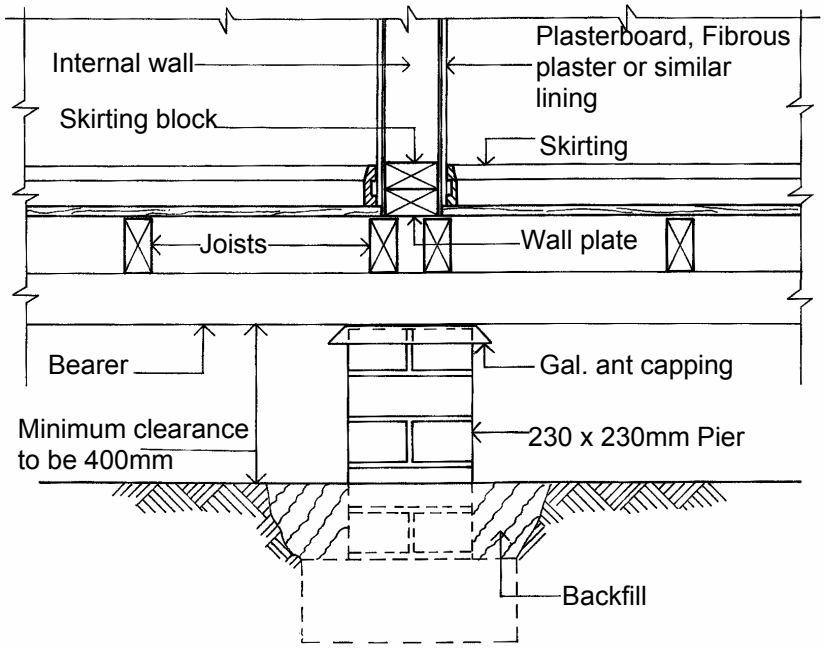


Fig. 84 Ground floor internal support system

SUSPENDED CONCRETE FLOORS

These floor systems may be used in conjunction with all three common wall construction types and are usually supported on masonry walls. The suspended concrete slabs are usually 100mm thick, depending on the span, and may be used for wet area floors such as bathrooms, toilets, laundries, etc. or for balconies and patios', which are exposed to the weather.

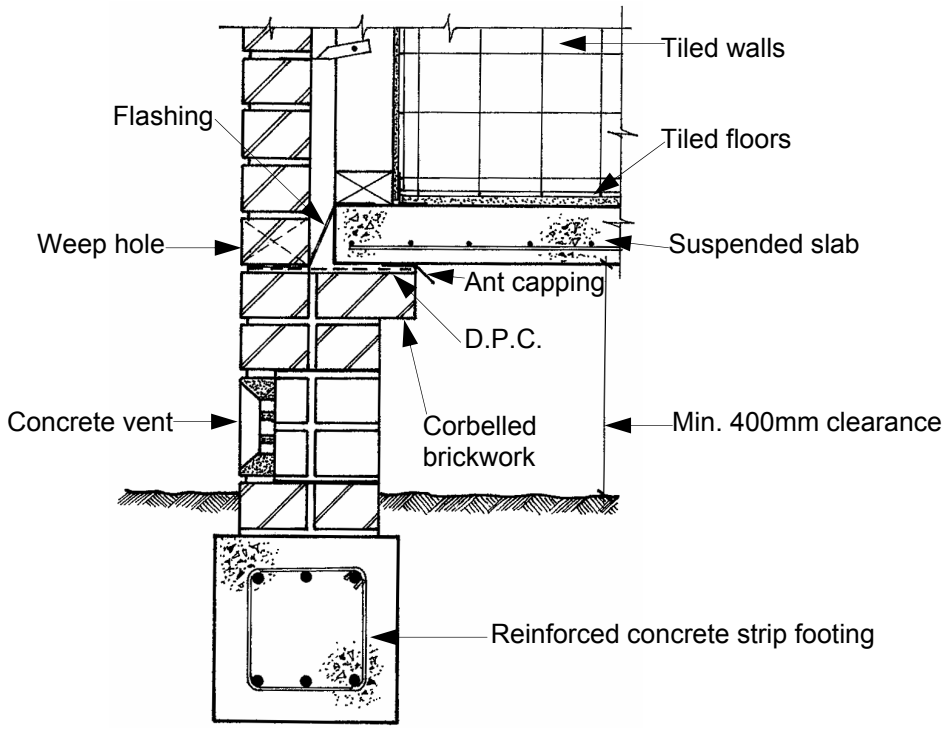


Fig. 85 Typical suspended wet area slab

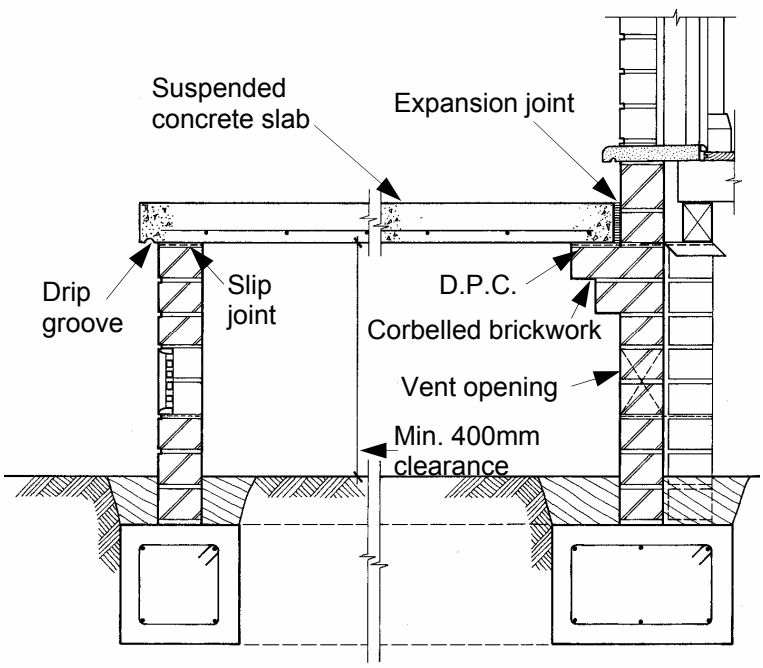


Fig. 86 Typical suspended patio slab

TIMBER WALL FRAME STUD CLUSTERS

Timber wall frames require stud clusters to provide vertical support for roof loads, provision for fixing of external claddings and fixing for internal linings. The most common methods used for external corners of wall frames are shown below:

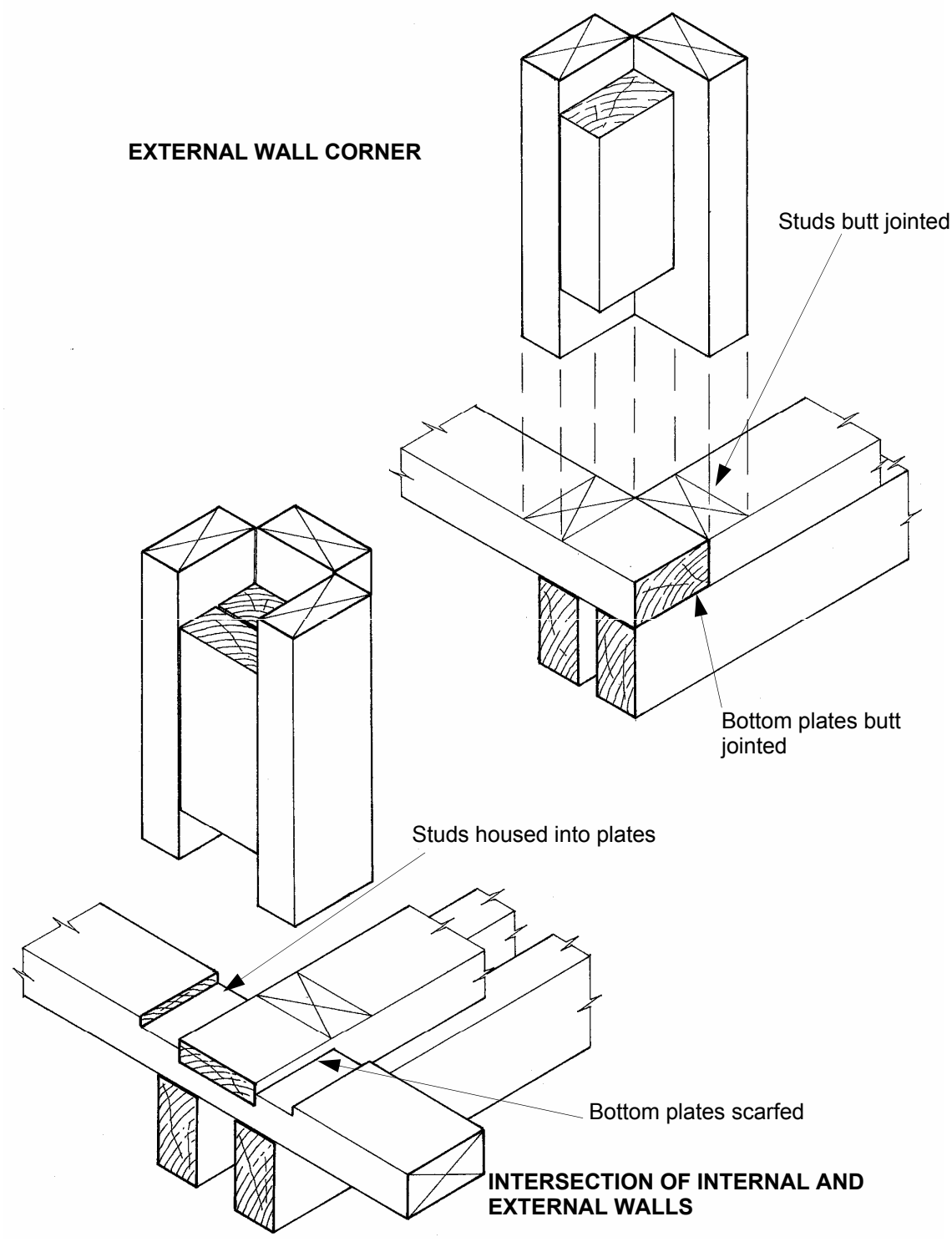


Fig. 87 Common wall frame stud clusters

WALL CONSTRUCTION

Residential cottages may have external walls consisting of timber frames clad with weatherboards, sheeting or other finishes, brick veneer or cavity brick construction. The walls and finishes are to be strong and *durable* enough to prevent entry by persons, animals and the weather.

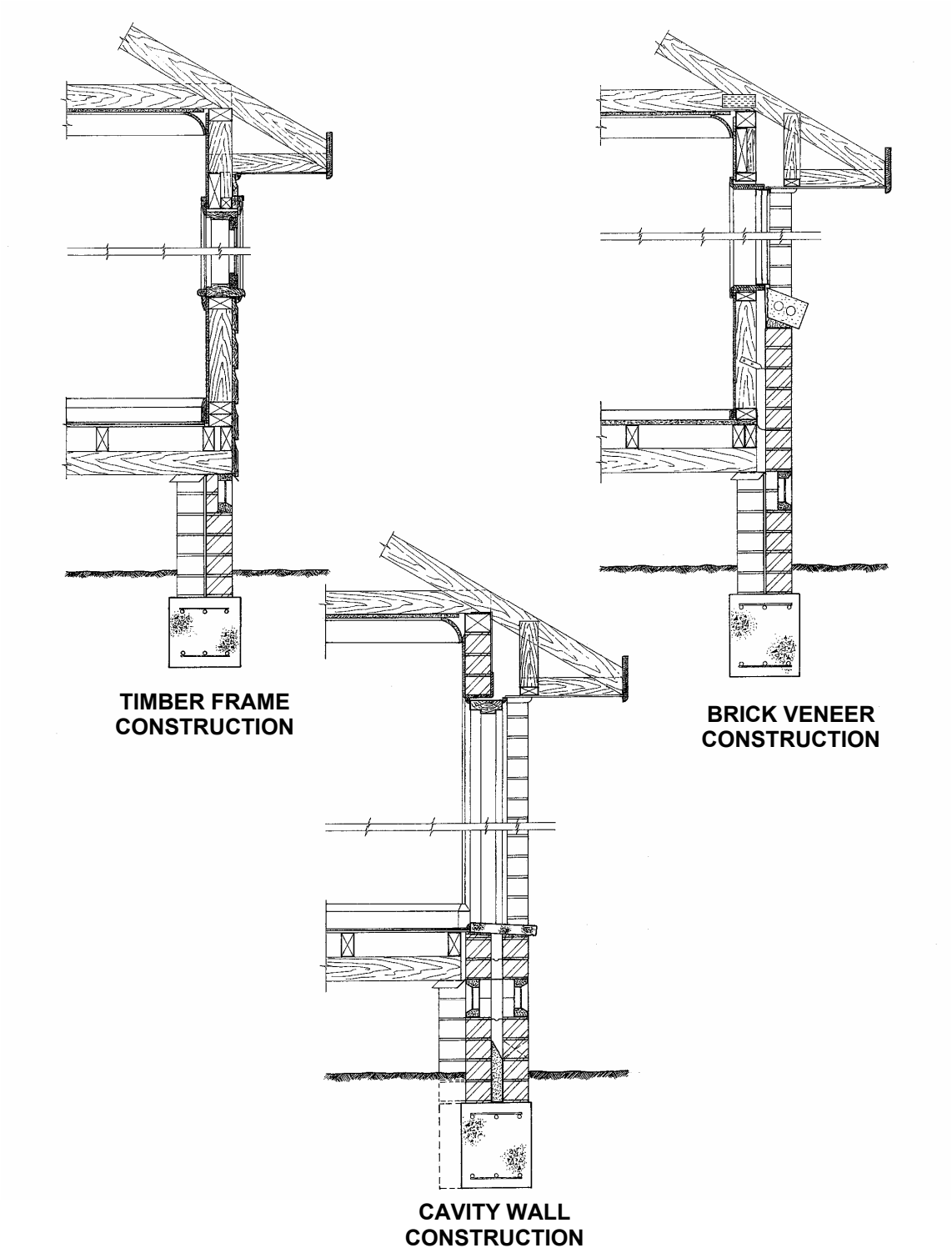


Fig. 88 Typical vertical sections through external walls

ROOF TYPES

Roofs are designed to shed water and protect the internal areas of a structure. There are many styles available ranging from lean-to and skillion to hip and semi-octagonal ended. They may be classified as single pitch, double pitch or unequal pitch. The method of construction may vary from conventionally cut and pitched to a pre-fabricated truss type. The most common styles are shown below:

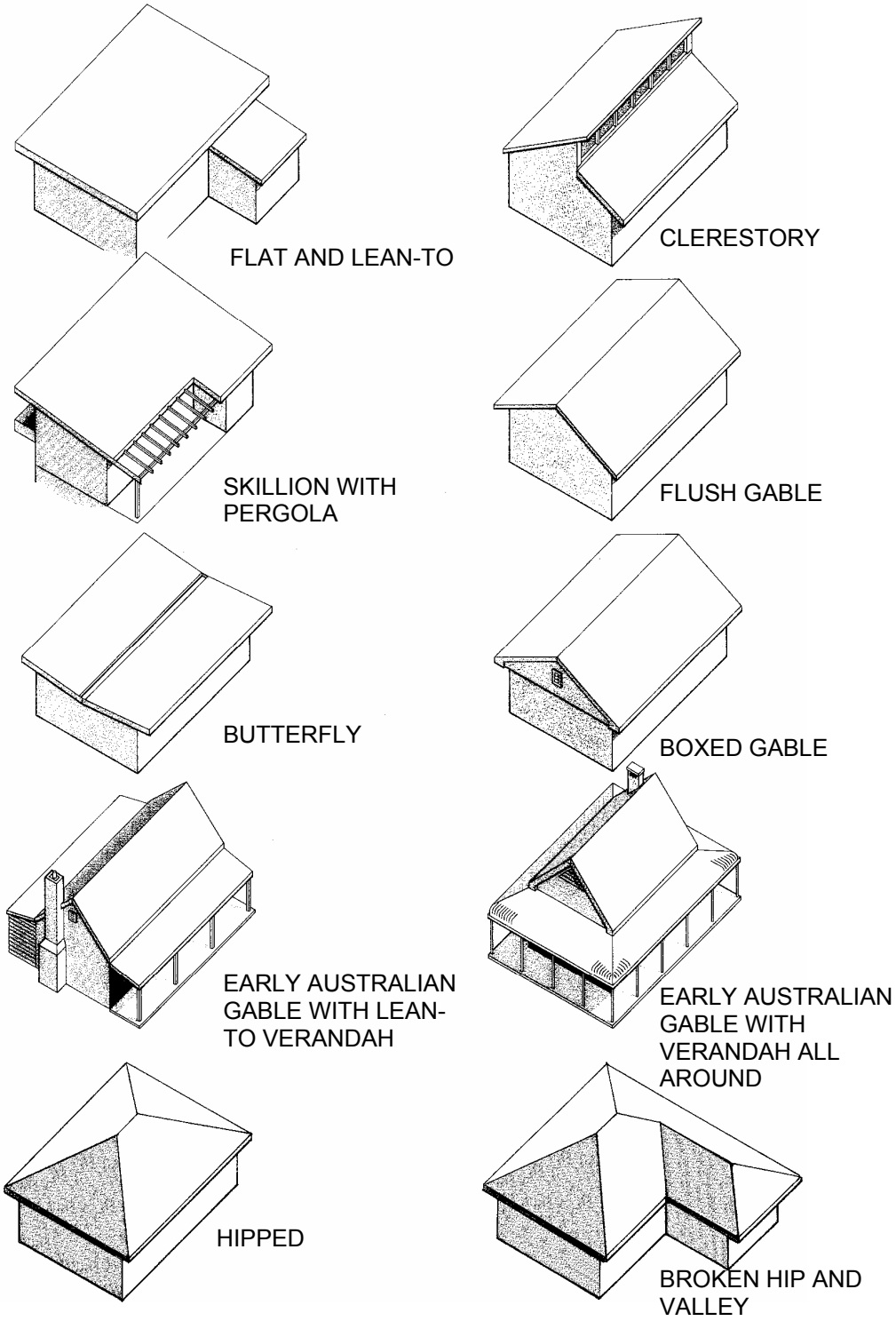
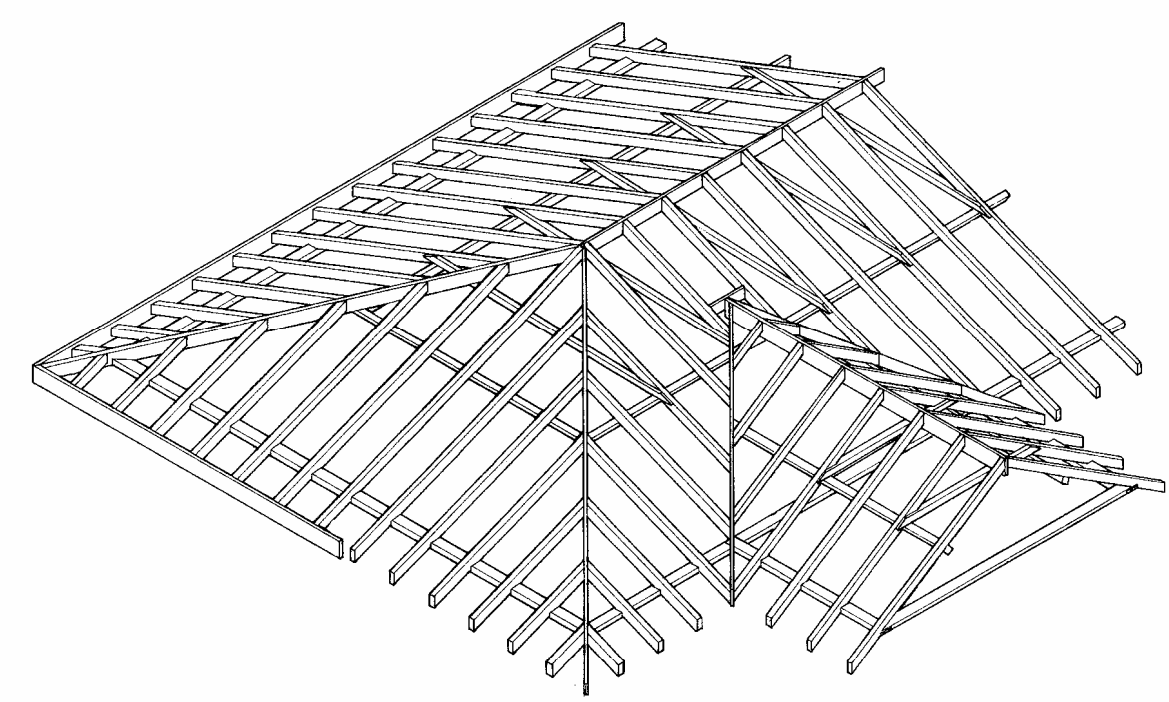
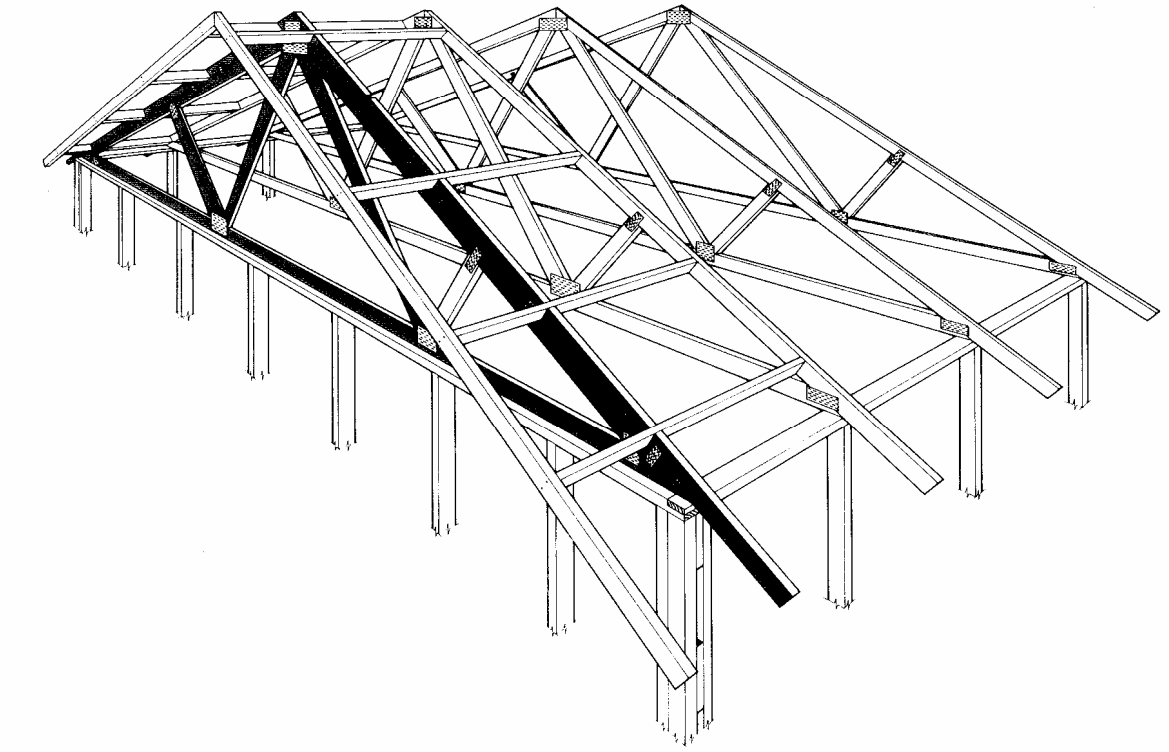


Fig. 89 Various roof styles

Common types of construction



CONVENTIONAL OR 'STICK' TYPE CONSTRUCTION



TRUSSED OR PRE-FABRICATED TYPE CONSTRUCTION

Fig. 90 Main types of construction

EAVE TYPES

Eaves are fitted to roofs to provide some shade and protection to walls and windows from the rain. Not all structures are fitted with eaves and therefore the roof may be referred to as having 'flush eaves'. Most cottages are fitted with either boxed, open or lined on-the-rake eaves with the option of a concealed or fascia gutter fitted around the perimeter.

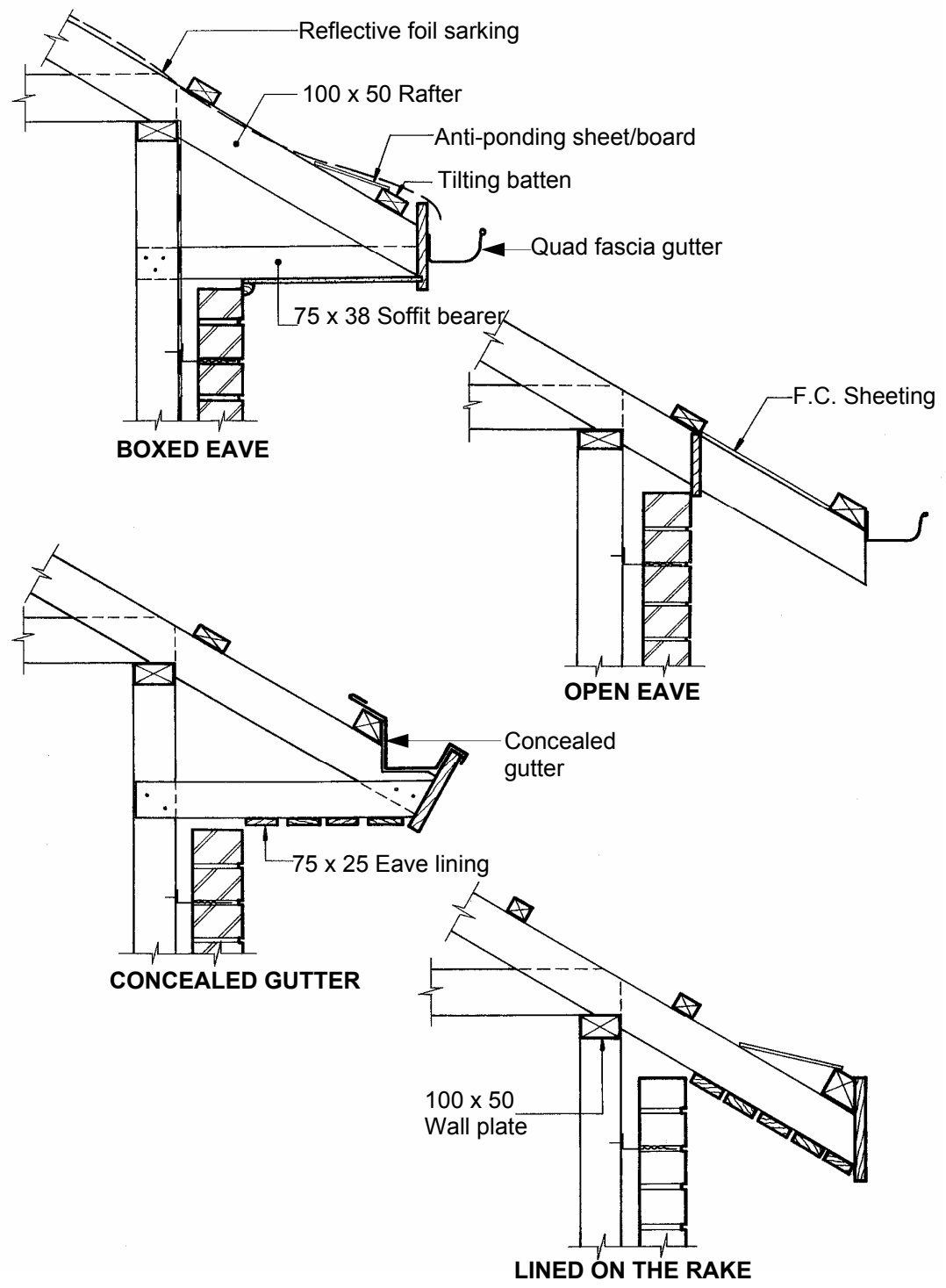
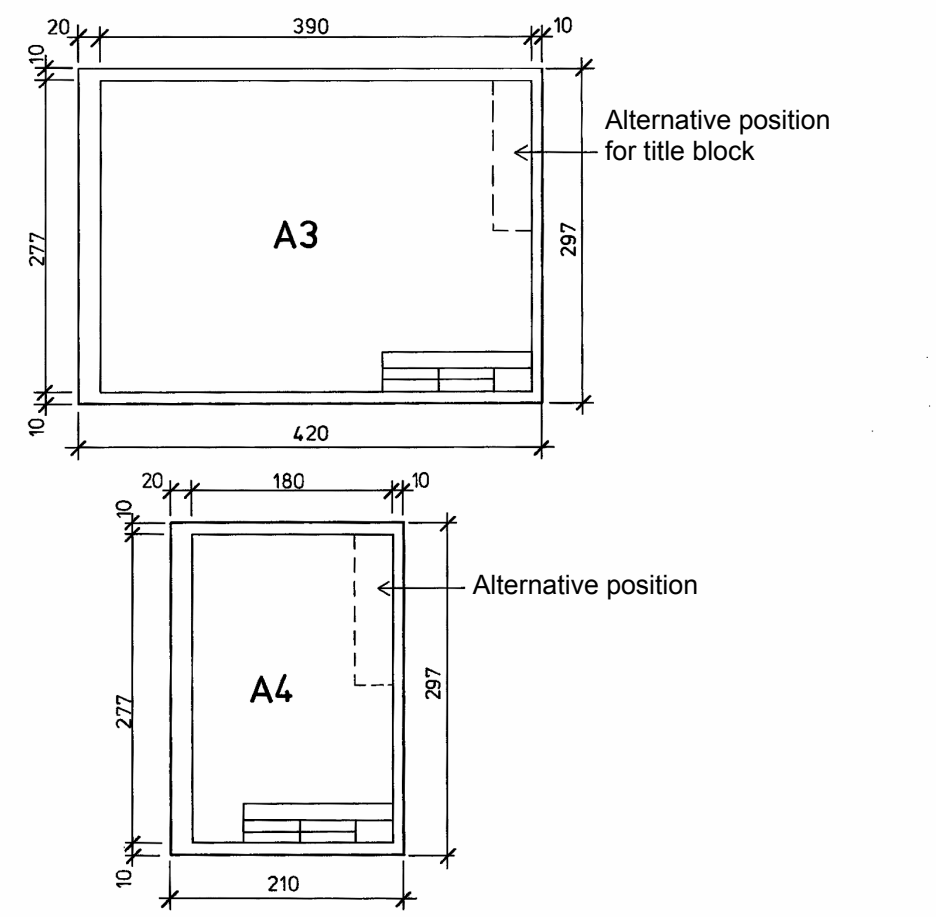


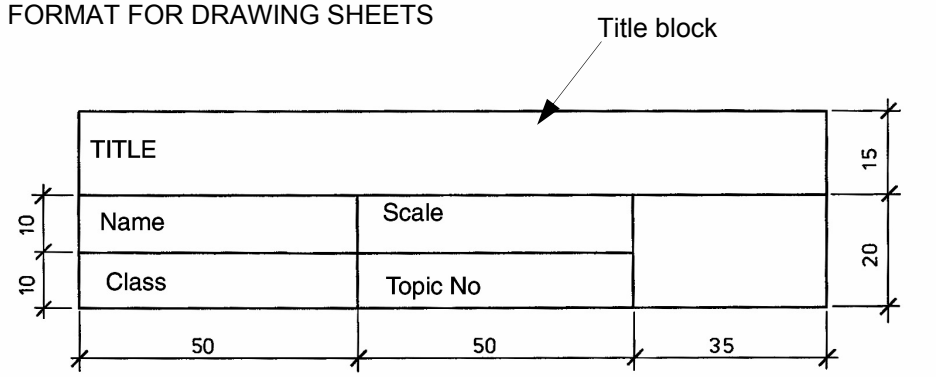
Fig. 91 Typical eave details

PRACTICAL DRAFTING

As previously mentioned in Unit 1, '*drawings are one of our most important means of communication'*, however if the details are not presented in a clear and concise manner the message could be misinterpreted. Therefore, a carefully planned and neatly set out drawing sheet is essential.
The following details outline the preferred format, whether plain cartridge paper or pre-printed paper is used:



FORMAT FOR DRAWING SHEETS



LAYOUT FOR TITLE BLOCK

Fig. 92 Sheet format

ORTHOGONAL OR ORTHOGRAPHIC PROJECTION

The word 'orthogonal' means to view an object at right angles with the lines of sight from any position, at right angles, will be parallel. In other words the only details which can be seen at any one time are those on one face.
Details may be presented in either 1st or 3rd angle projection as follows:

- 1st *angle*: the elevation is on top, the plan is directly underneath, and the side elevation is shown on the right top side as viewed from the left.
- 3rd *angle*: the plan is on the top, the elevation is directly underneath, and the side view is on the left bottom side as viewed from the right.

Although combinations of 1st and 3rd angle may be used, building details are usually drawn in '1st angle projection'.
These 'views' of a three dimensional object are seen as:

- Front vertical plane (FVP) and shown on a drawing as the *'Front Elevation'*
- Side or end vertical plane (SVP) and shown on a drawing as the *'Side or End Elevation'*
- Horizontal plane (HP) and shown on a drawing as the *'Plan'*

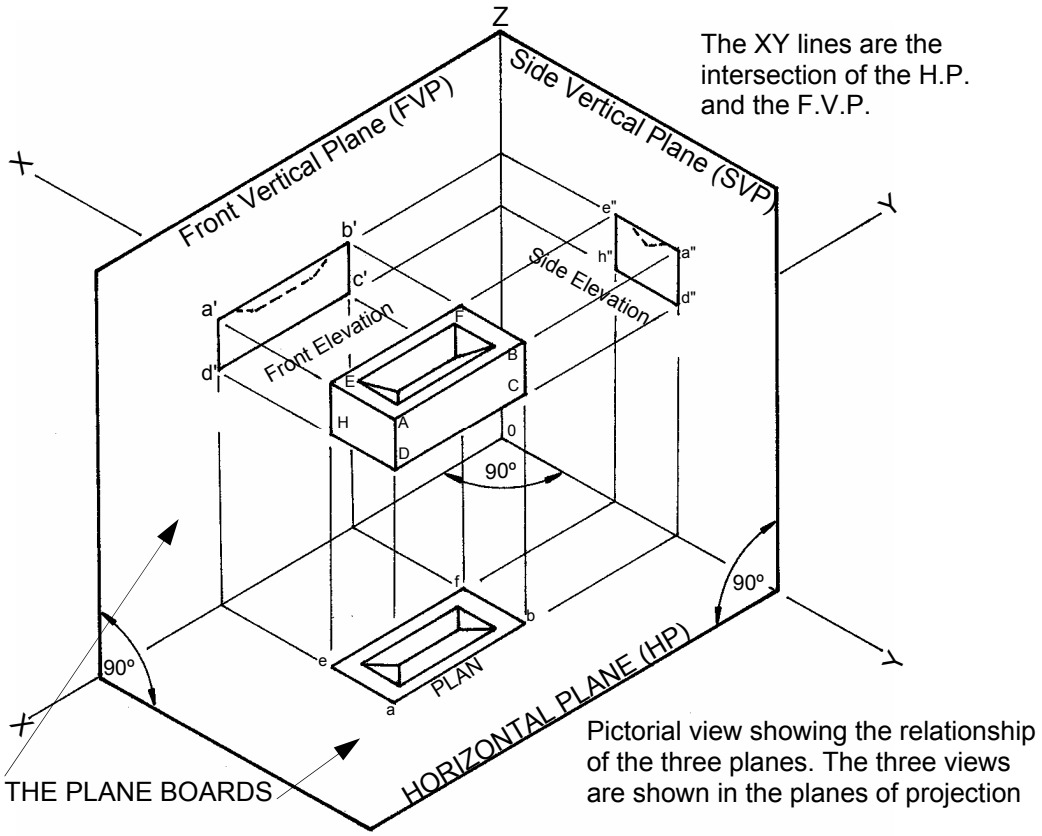


Fig. 94 Pictorial view of a three dimensional object (dry pressed brick)

Setting out the Drawing Sheet

An A3 or A4 drawing sheet is best divided up with a vertical line or plane, known as the V.P., and a horizontal line or plane, known as the H.P. The views of the object are placed an equal distance apart from these starting lines. This allows the points of the object to be projected up, down or across easily and accurately.

***Note**: When projecting the points for the side elevation a 45° intersection line may be used, or alternatively the points may be projected or transferred using a compass from the V.P. to the H.P. as shown below:*

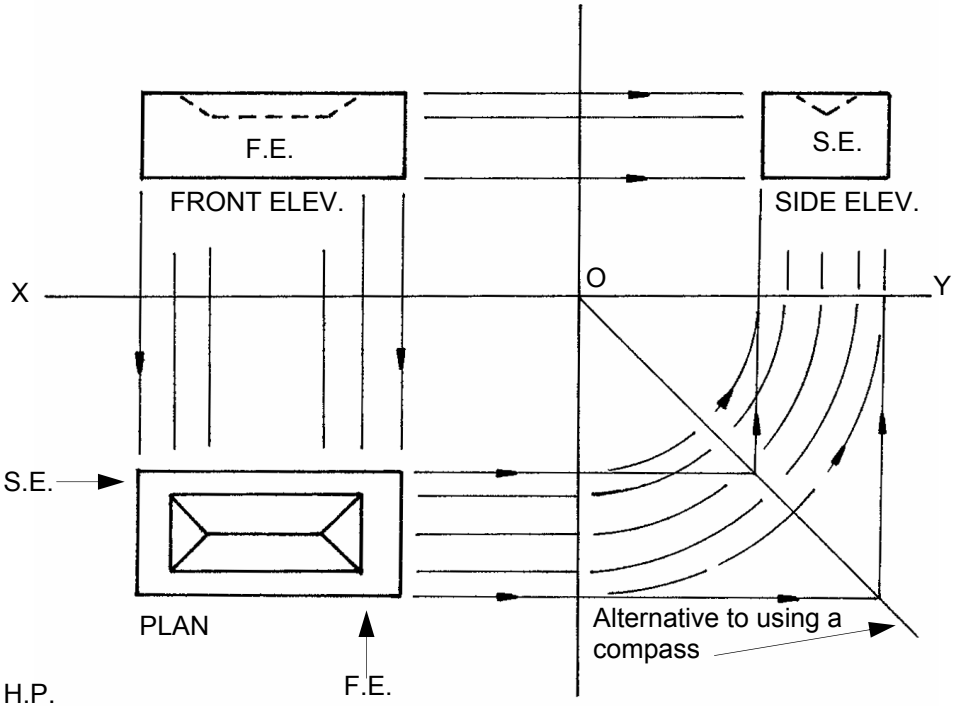


Fig. 95 1st angle projection sheet layout and projection lines (dry pressed brick)

Notation and Dimension Lines

Uppercase lettering is preferred when naming views or providing notes on details, however lowercase lettering may be used for notes also. When naming or identifying a particular view, it is usual to place the wording under the view beginning at the left corner. A space between the view and the wording should be left so it does not interfere with the detail of the drawing.

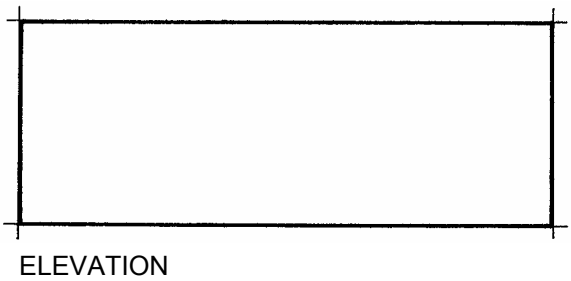


Fig. 96 Identifying a view

- Dimension lines should always be shown on a drawing and they should be thin in relation to the drawing outline, regardless of whether pencil or ink is being used;

- Dimension figures should be centrally placed immediately above and parallel to the dimension lines; and

- All dimension figures should be arranged so that they may be read from the bottom or the right hand side of the drawing.

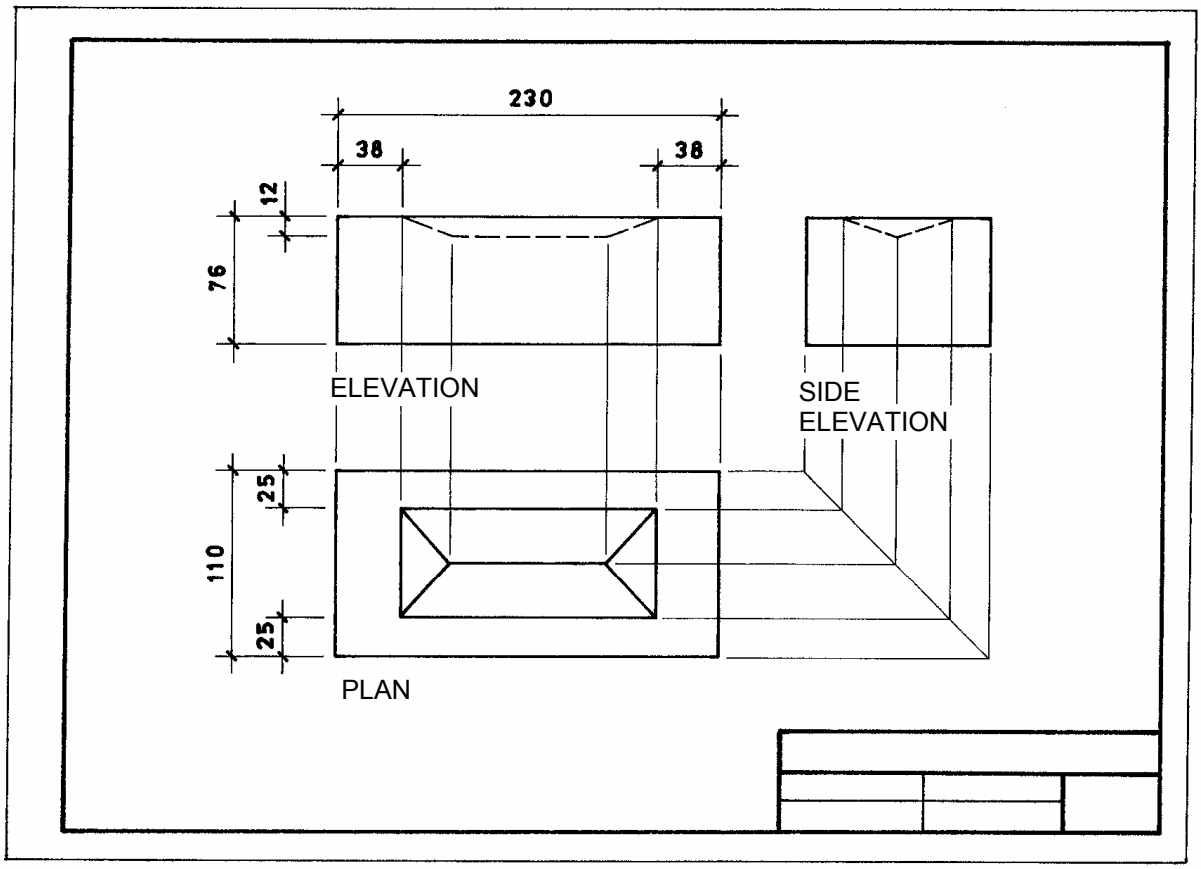


Fig. 97 Completed drawing with dimensions and notation

AXONOMETRIC PROJECTION

This type of drawing is classified as being 'pictorial', which means it provides a three dimensional representation on a flat surface. Axonometric projection has the advantage over other types of pictorial drawing by providing a true plan and therefore it may be more easily used for projecting directly from orthographic views. This style of drawing is commonly used to show the interiors of rooms and layouts for kitchens, etc.
The details may be drawn at any convenient angle providing the opposite angle is complimentary, i.e. both angles must equal 90°. Therefore, when using a T-square and set squares the most convenient angles will be 45° / 45° or 60° / 30°.
The drawing outline will be firmed in but construction lines should be shown as dotted or broken lines. Also, any hidden lines will be shown as dotted or broken lines to give the impression that this is a three dimensional object which has clear sides. Showing hidden detail allows the viewer to see special details, the termination points of supports or the actual thickness of the object, which would otherwise be blocked due to the opaque nature of solid objects.
It should also be noted that circles appear to be true shapes on plan but are seen as ellipses on the elevation. Where circles are drawn on the elevation the construction lines should be shown and used to provide the various radius centres, to enable the ellipse to be drawn.

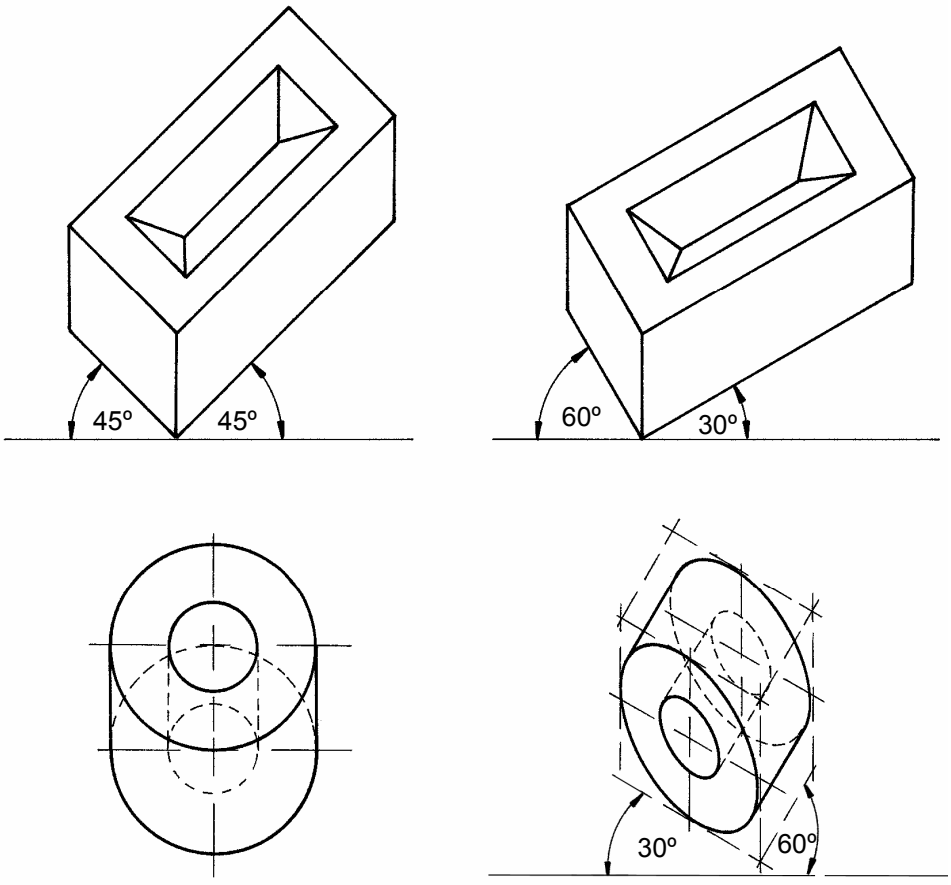


Fig. 98 Axonometric details

ISOMETRIC PROJECTION

This type of projection is similar to axonometric although the plan view is no longer a true shape. It becomes distorted due to the angles used, however in some cases the detail appears to be realistic.
The convenient angle used for this projection is 30° / 30° with all vertical lines being perpendicular to the horizontal plane. Circles take on an elliptical shape both on plan and on the elevations, therefore they require construction lines and the centres of the arcs accurately plotted. Alternatively, elliptical templates may be used to produce the same results.
Dimension lines and dimensions are shown on the same angle as the detail and should be placed on top and in centre of the lines.
This method of projection is also classified as being 'pictorial' and an example is shown below:

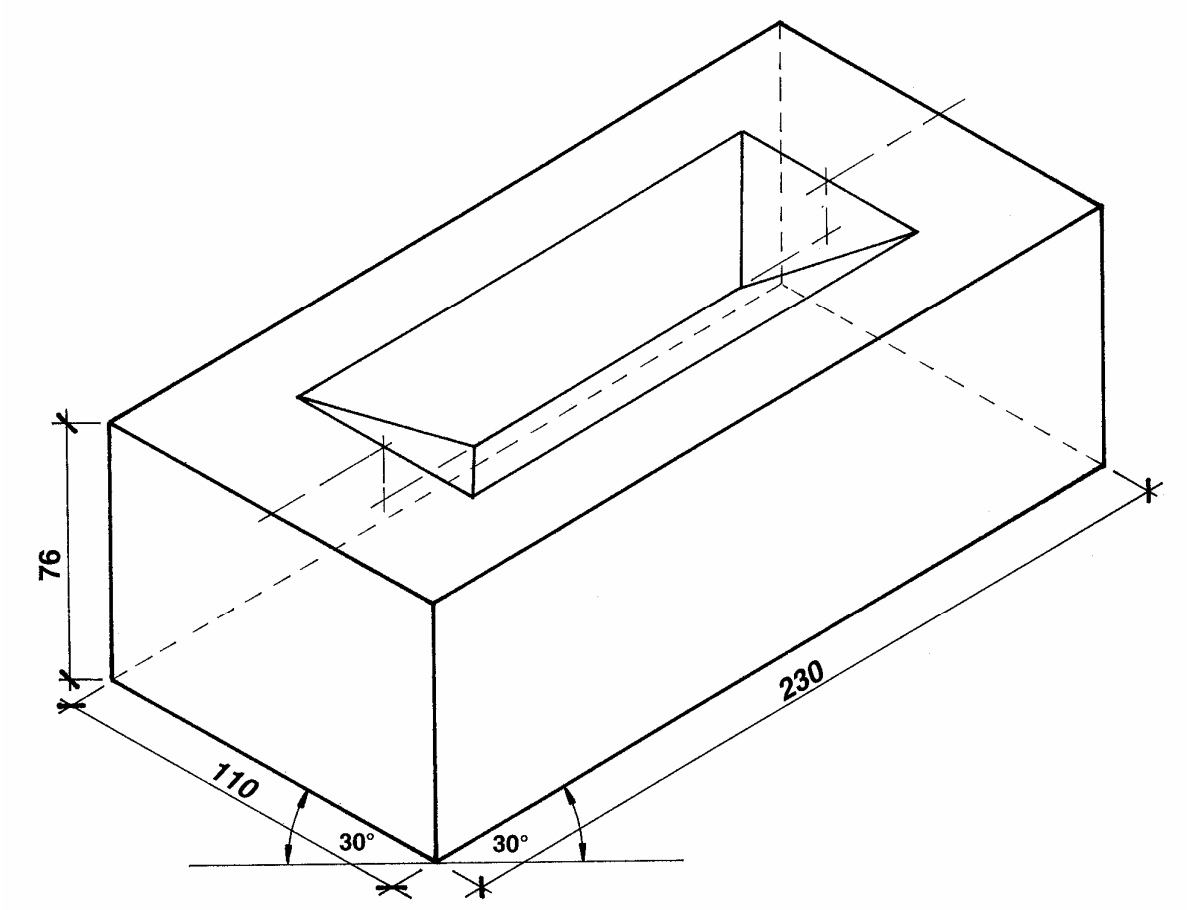


Fig. 99 Isometric view (dry pressed brick)

OBLIQUE PROJECTION

This is also classified as a 'pictorial' projection with the front elevation being a true shape and the plan and side elevation drawn in an oblique view, i.e. at an angle. This method is used to show details of buildings or objects where the front elevation needs to be shown at the correct size and proportion, and the other views are not as important. There are two basic methods used to produce the end result:

1. The oblique lines are drawn at 45° to the horizontal plane. All the vertical and horizontal lines are drawn at full size, or in a nominated scale, and the oblique lines are drawn at half full size, or half the nominated scale.
2. The oblique lines are drawn at 30° to the horizontal plane and all lines are drawn full size, or at a nominated scale.

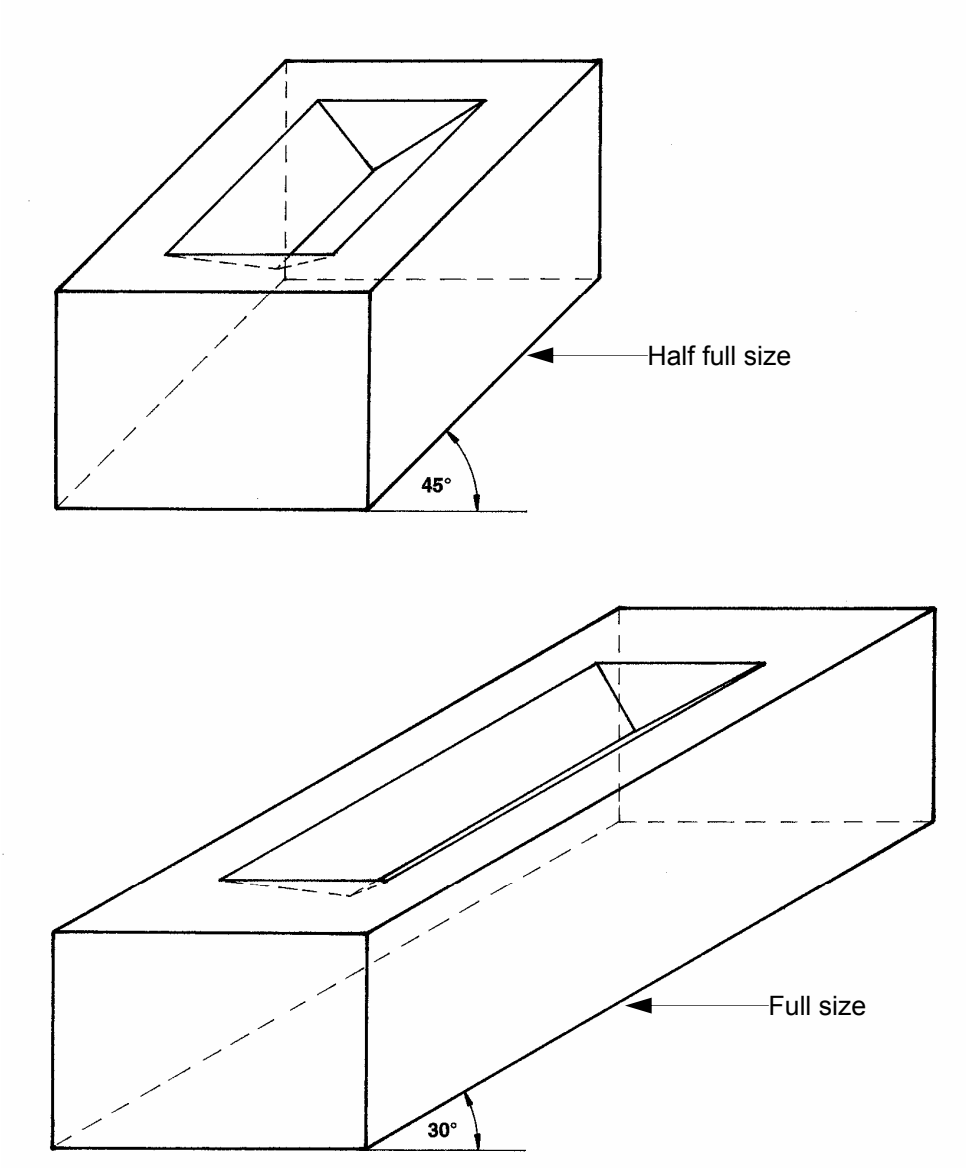


Fig. 100 Oblique views (dry pressed brick)

GLOSSARY OF TERMS

Anobium puncatum - This is the Latin or scientific name for the Furniture beetle, which in its larval form can cause severe damage to pine timbers by boring through it, leaving a honeycomb effect and a gritty dust.

Antcapping - Galvanised or 'Zincalume' metal sheet and/or strips with one or more folded edges at 45°. They are placed on top of piers and dwarf walls to act as a physical barrier to expose termite entry.

Bullnose - A quadrant or quarter round shape on the edge of timber, bricks, roof sheeting, etc.

Camber - This refers to a slight curving up of the top edge of a member such as found on a hand saw blade, bottom chord of a truss, framing members, etc.

Chattering - This is the action of the blade of a tool, eg. a plane, when used on timber especially if the blade is blunt or is not firmly supported. The result is a series of shallow cut marks left on the surface.

Concave - This refers to a surface with a hollow curved shape such as found on the inside of a pipe or gutter.

Conical - This means cone-like. Any shape which is like a rounded pyramid.

Convex - This refers to an external surface with a full curved shape such as found on the outside of a pipe or pole.

Dovetail - This name is given to the shape of a particular timber joint, as it resembles the tapered appearance of a doves' tail.

Drop-forged - Moulded metal objects formed by dropping a heavy hammer, or similar, to beat the heated metal into shape such as for the creation of spanners or moulded tools.

Dry-pressed bricks - Solid clay bricks, which are formed by pressing clay materials into steel forms. They usually have a frog or indent on one face.

Duplex - Made up of two parts such as a duplex cottage with a party wall between two residences or a duplex plane which has two blades, etc.

Durable - Long lasting and will stand up to the effects of weathering or adverse conditions and exposure.

Elevation - May refer to the front or side view of an object in Orthographic drawing, or may refer to the height of a level when used in site setting out.

End grain - This is found on the end of a length of timber where the ends of the vertical grain, and the pores or vessels between them, are visible.

Fence - In carpentry or joinery terms it means to temporarily fit or cramp a piece of timber along the edge of a proposed cutting line. It provides a guide for a saw or chisel to follow so the cut is made accurately.

Flare - To open up at the end with tapering sides. A dowel hole is flared at the end by countersinking.

Grain - May refer to the fibres visible in timber or the granular material used for manufacturing abrasive papers for sanding timber.

Grit - Refers to the granular abrasive used for the manufacture of abrasive papers. Is also known as *grain.*

Hydrostatic - Literally means 'still water'. Therefore, it is the balancing of water or water pressure, as found in the water level. The surface needs to be balanced and still in both ends of the tube to be able to record an accurate reading.

Jig - This may be a template, mould or a guide used for repetitive work or where accuracy is required.

Kerf - The incision made by cutting with a saw, hence the term 'saw kerf'.

Knurled - This is common texture applied to steel handles of tools and machinery to provide a grip. The recessed lines cross over at 45° and are applied using a knurling tool.

Masonry - Refers to the materials used by a Mason such as stone, brick, terra cotta, concrete or artificial stone, laid in mortar.

Millet - The stalk of a grain bearing plant used to make brooms.

Nap - The projecting threads or fibres of a fabric, which is trimmed to an even length such as found on a wool paint roller.

Neoprene - This is a durable, flexible, slip-resistant and oil-resistant synthetic rubber compound, which is used for gaskets, roofing screw washers, sealing rings, etc.

Notation - Descriptive wording , lettering or numbers added to drawing details to describe parts, materials, spacings, etc.

Patio - Forms part of cottage architecture where an outdoor area is enclosed by a fence, handrail, columns or posts. It may also be in the form of a deck with an awning or lean-to roof over.

Phenolic resin - A strong brittle resin formed from benzene and more commonly called 'Carbolic acid'. It may be used for coating or bonding, production of 'Laminex', electrical goods, hard toilet seats, etc.

Pictorial - Means to create a picture-like image. Pictorial views are usually single line graphics, which represent an object in a three dimensional form.

Plumb - To be exactly vertical or perpendicular.

Plumbum - Means the heavy base metal used for fishing sinkers, insulation material, flashing for buildings, etc. It is sometimes referred to as Plumbum nigrum, 'Black lead' - a name for graphite, or Plumbum album, 'White lead', a name for tin.

Podger - A short stout tool or lever used to lever telescopic members apart, as is the case with steel telescopic formwork floor centres

Polypropylene - Is a form of plastic material used for furniture and pipe fittings and is particularly resistant to organic solvents, acids and alkalis. It may also be 'welded' to form strong pipe connections.

Roof pitch - This is the angle or slope of a roof surface and is usually stated in degrees or given as a ratio of rise per metre run.

Rebate -	This is a rectangular or square section taken out of the edge and face of a piece of timber. It has also been referred to as a 'rabbet'.
Rung -	One of the round or moulded crosspieces fitted between two stiles of a ladder, which are like steps.
Scribing -	Cutting a piece of timber to fit over the shape of another piece. It is commonly used to joint moulded skirtings at an internal corner.
Shoulder -	The portion of a piece of timber which fits tightly up against another, when making a joint.
Wet area -	This is a generic term, which is applied to any area in a cottage where the surfaces of the floors and/or walls are protected from the effects of free water. Such areas include bathrooms, toilets, laundries, ensuites, tiled balconies, etc.

FURTHER READING

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VIDEOS

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ISBN 0-7348-0998-0

9780734809988